

PHILOSOPHICAL
TRANSACTIONS,
OF THE
ROYAL SOCIETY
OF
LONDON.

FOR THE YEAR MDCCCXXIII.

PART I.

LONDON:

PRINTED BY W. NICOL, SUCCESSOR TO W. BULMER AND CO.
CLEVELAND-ROW, ST. JAMES'S;
AND SOLD BY G. AND W. NICOL, FALL-MALL, PRINTERS TO THE
ROYAL SOCIETY.
MDCCCXXIII.

PHILOSOPHICAL
TRANSACTIONS

OF THE

ROYAL SOCIETY

OF

LONDON

FOR THE YEAR MDCCXXIII

PART I

LONDON

PRINTED BY W. BENTLEY, ST. MARTIN'S LANE

AND SOLD BY A. MILLAR, ST. MARTIN'S LANE

AND SOLD BY A. MILLAR, ST. MARTIN'S LANE

MDCCXXIII

MDCCXXIII

ADVERTISEMENT.

THE Committee appointed by the *Royal Society* to direct the publication of the *Philosophical Transactions*, take this opportunity to acquaint the Public, that it fully appears, as well from the council-books and journals of the Society, as from repeated declarations which have been made in several former *Transactions*, that the printing of them was always, from time to time, the single act of the respective Secretaries, till the Forty-seventh Volume: the Society, as a Body, never interesting themselves any further in their publication, than by occasionally recommending the revival of them to some of their Secretaries, when, from the particular circumstances of their affairs, the *Transactions* had happened for any length of time to be intermitted. And this seems principally to have been done with a view to satisfy the Public, that their usual meetings were then continued, for the improvement of knowledge, and benefit of mankind, the great ends of their first institution by the Royal Charters, and which they have ever since steadily pursued.

But the Society being of late years greatly enlarged, and their communications more numerous, it was thought advisable that a Committee of their members should be appointed, to reconsider the papers read before them, and select out of them such as they should judge most proper for publication in the future *Transactions*; which was accordingly done upon the 26th of March, 1752. And the grounds of their choice are, and will continue to

be, the importance and singularity of the subjects, or the advantageous manner of treating them; without pretending to answer for the certainty of the facts, or propriety of the reasonings, contained in the several papers so published, which must still rest on the credit or judgment of their respective authors.

It is likewise necessary on this occasion to remark, that it is an established rule of the Society, to which they will always adhere, never to give their opinion, as a Body, upon any subject, either of Nature or Art, that comes before them. And therefore the thanks, which are frequently proposed from the Chair, to be given to the authors of such papers as are read at their accustomed meetings, or to the persons through whose hands they received them, are to be considered in no other light than as a matter of civility, in return for the respect shown to the Society by those communications. The like also is to be said with regard to the several projects, inventions, and curiosities of various kinds, which are often exhibited to the Society; the authors whereof, or those who exhibit them, frequently take the liberty to report, and even to certify in the public news-papers, that they have met with the highest applause and approbation. And therefore it is hoped, that no regard will hereafter be paid to such reports and public notices; which in some instances have been too lightly credited, to the dishonour of the Society.

CONTENTS.

- IX. *The Croonian Lecture. Microscopical observations on the suspension of the muscular motions of the *Vibrio Tritici*.* By FRANCIS BAUER, Esq. F. R. S. F. L. S. and H. S. p. 1
- X. *On Metallic Titanium.* By W. H. WOLLASTON, M. D. F. R. S. p. 17
- XI. *On the difference of structure between the human Membrana Tympani and that of the Elephant.* By Sir EVERARD HOME, Bart. V. P. R. S. p. 23
- XII. *Corrections applied to the Great Meridional Arc, extending from latitude $8^{\circ} 9' 38''$, 39, to latitude $18^{\circ} 3' 23''$, 64, to reduce it to the Parliamentary Standard.* By Lieutenant Colonel W. LAMBTON, F. R. S. and Corresponding Member of the Royal Academy of Sciences at Paris. p. 27
- XIII. *On the changes which have taken place in the declination of some of the principal fixed Stars.* By J. POND, Esq. Astronomer Royal, F. R. S. p. 34
- XIV. *Appendix to the preceding Paper on the changes which appear to have taken place in the declination of some of the fixed Stars.* By JOHN POND, Esq. Astronomer Royal, F. R. S. p. 39
- XV. *On the parallax of a Lyra.* By JOHN POND, Esq. Astronomer Royal, F. R. S. p. 53
- XVI. *Observations on the heights of places in the Trigonometrical Survey of Great Britain, and upon the Latitude of Arbury Hill.* By B. BEVAN, Esq. Communicated by Sir H. DAVY, Bart. P. R. S. p. 73

CONTENTS.

- IX. *On some Fossil Bones discovered in Caverns in the Limestone Quarries of Oreston.* By JOSEPH WHIDBEY, Esq. F.R.S.
In a Letter addressed to JOHN BARROW, Esq. F. R. S. To which is added, a Description of the Bones by Mr. WILLIAM CLIFT, Conservator of the Museum of the College of Surgeons.
 p. 78
- X. *On the Chinese Year.* By J. F. DAVIS, Esq. F. R. S. p. 91
- XI. *Experiments for ascertaining the Velocity of Sound, at Madras in the East Indies.* By JOHN GOLDINGHAM, Esq. F. R. S. p. 96.
- XII. *On the double Organs of Generation of the Lamprey, the Conger Eel, the common Eel, the Barnacle, and Earth Worm, which impregnate themselves; though the last from copulating, appear mutually to impregnate one another.* By Sir EVERARD HOME, Bart. V. P. R. S. p. 140

APPENDIX.

Meteorological Journal kept at the Apartments of the Royal Society, by Order of the President and Council.

THE President and Council of the Royal Society adjudged the Medal on Sir GORDON COMPTON FOUNDATION for the year 1932 to the Rev. WILLIAM BOCKLAND, F.R.S. Professor of Mineralogy and Geology in the University of Oxford, &c. &c. for his Paper printed in the Philosophical Transactions of that year.

THE PRESIDENT and COUNCIL of the ROYAL SOCIETY adjudged the Medal on SIR GODFREY COPLEY's Donation for the year 1822, to the Rev. WILLIAM BUCKLAND, F. R. S. Professor of Mineralogy and Geology in the University of Oxford, &c. &c. for his Paper printed in the Philosophical Transactions of that year.

PHILOSOPHICAL
TRANSACTIONS.

1. *The Croonian Lecture. Microscopical observations on the suspension of the muscular motions of the Vibrio Tritici.* By FRANCIS BAUER, Esq. F. R. S. F. L. S. and H. S.

Read December 5, 1822.

THE Croonian Lecture has usually been given by Members who had made Physiology their particular study; and I should not have ventured upon this task, had I not been encouraged by one of our Vice-Presidents, who has now, for some years, applied my microscopical observations in promoting physiological enquiries into the more minute parts of animal structure.

Without his authority, I should not have ventured to bring forward the following observations, respecting the length of time the moving powers of an animal, too small to become the object of sight without the assistance of the microscope, can have its action suspended, and again, by a change of circumstances, renewed.

This, he is induced to believe, is one of the most curious facts respecting muscular motion that has hitherto been as-

certained, and not undeserving of the notice of the Society, particularly when laid before its members as a part of this Lecture, to which it most peculiarly belongs.

This minute animal, the *Vibrio Tritici*, is the immediate cause of that destructive disease in wheat, known under the name of Ear Cockle, or Purples, by farmers.

On opening some of the diseased grains, I found their cavities filled with a mass of a white fibrous substance, apparently cemented together by a glutinous substance, and formed into balls, which could easily be extracted entire from the cavities of the grains, and which, when immersed in water, instantly dissolved, and displayed in the field of the microscope, hundreds of perfectly organized, extremely minute worms, all which, in less than a quarter of an hour, were in lively motion.

Having left some of these worms on a glass for five days in a perfectly dry state, they were apparently dead; but when moistened, they were again, in less than half an hour, as lively as ever.

These experiments and results were so far satisfactory, as they incontestibly established the fact, that the fibrous substance within the cavities of the diseased wheat grains, consists of real organized animals, which are endowed with the extraordinary property, of having their muscular action suspended for a considerable length of time, and of having it renewed again by the mere application of moisture: but how these animals are propagated, and how they are introduced into the cavities of the young germens, appeared to me a mystery, which I was convinced could only be unravelled by tracing them through every stage of the germination and

vegetation of the growing plant of wheat; and believing that the eggs of these worms must be conveyed into the cavities of the very young germens of the flowers of wheat by the circulating sap, in the same manner as the seed of the parasitical fungi which occasion the well-known disease in wheat, the smut-balls, and which I had, in former experiments, successfully inoculated upon sound wheat, I determined to try the same experiment with these worms. I therefore selected some sound grains of wheat, and placed some portions of the mass of worms in the grooves on the posterior sides of the grains, and planted them in the ground in the month of October, 1807. Nearly all the seeds came soon up, and I took from time to time some of the young plants for examination, but could not perceive any effect of the inoculation, till the month of March, 1808, when, in carefully slitting open the short stalk of a young plant, I found three or four worms within it; they were in every respect the same, but they were now about two-thirds larger, as well in length as in diameter.

On the 5th of June I found, for the first time, some of the worms, of different sizes, within the cavities of the young germens; and having, in the beginning of March, found some of them in an enlarged state in the stalk, I concluded that some of the original worms, with which I had inoculated the grains of seed, had got, during the germination of the grains, into the stalk, where they became mature, and laid their numerous eggs, some of which must be carried by the circulating sap into the cavities of the then forming young germens, in which the young worms extricate themselves from these eggs; and finding their proper nourishment

within the cavities of the germens, these young worms become of mature age, and lay their eggs within the cavities of these germens, which at that period nearly approach towards maturity; and these newly laid eggs, I consider to be the beginning of the third generation of the worms with which I had inoculated the grains planted in the ground in October, 1807.

Since the 5th of June, I regularly examined every second or third day an ear, to observe the progressive advancement, as well of the worms as of the germens; towards the end of June, the germens assumed various distorted forms, and began to be filled with eggs. I extracted carefully the whole contents of one of the largest grains, and putting it into water in a watch-glass, I found, on examination under the microscope, seven large worms, a great many eggs, and at least a hundred young worms, all alive, bending and twisting in the water like so many small serpents.

The natural size of the largest of these seven worms I found, by means of the micrometer, to be something more than $\frac{1}{4}$ part of an inch in length, and about $\frac{1}{10}$ part of an inch in diameter. They are more of a yellowish-white colour than the young worms, and are not so transparent; their heads are very distinct; they have a kind of proboscis, which has three or four joints, which they contract or extend like an opera glass. From the head, which is somewhat roundish, they taper gradually off towards the tail, which is scarcely half the diameter of the middle of their body, and ends in an obtuse claw-like point. At a short distance from the end of the tail is an orifice, surrounded by an elevated fleshy edge; from this orifice the worms discharge their eggs. The back

of these old worms is nearly opaque, and appears jointed, or annular; the number of joints, or rings, is from twenty-five to thirty; the belly side is more transparent; and strings of ova can be distinctly seen, through almost the whole length of the worm, to the orifice by which the eggs are discharged.

The movements of these large worms are very faint and slow; they are very seldom observed to unroll themselves entirely; they move their heads and tails faintly, but their proboscis they move constantly, extending and contracting it quickly; and when in the act of discharging their eggs, they bend the tailpiece upwards with a very quick jerk, at the passing of every egg; after having discharged all their eggs, the parent worms soon die, and in a few days they decay, and fall to pieces almost at every joint.

The eggs come out from the orifice in strings of five or six, adhering to one another at their ends, which then appear truncated; but, in water, they soon separate, and assume an oval form, which, in its middle, is slightly contracted. These eggs consist of an extremely thin and transparent membrane, through which the young worm can be distinctly seen; and, if attentively observed, it may be seen moving within this envelope. The egg is about $\frac{1}{300}$ part of an inch in length, and $\frac{1}{800}$ or $\frac{1}{900}$ part of an inch in diameter.

In about an hour and a half after the egg is laid in water, the young worm begins to extricate itself from the egg. One extremity of the worm (which I consider to be the head) comes out at one end of the egg; and by continual twisting and active exertion, the young worm comes gradually entirely out. I watched one individual from the first appearance of its head till it was entirely extricated, the operation was

effected in one hour and twelve minutes. The eggs, after the worms have quitted them, soon shrivel and decay, and it seems they ultimately dissolve, as in a very few days they entirely disappear, as well those in the water, as those that have been hatched within the germens.

The young worms are somewhat smaller and more transparent than those which are found in the more mature grains, but in a very short time after they have mixed with the others, they cannot be distinguished from them. Those which are found in the cavities of the mature grains, are nearly all of the same size; they are from $\frac{1}{33}$ to $\frac{1}{38}$ part of an inch in length, and $\frac{1}{1100}$ part of an inch in diameter. They are milk-white, semi-transparent; and if viewed with the strongest magnifying power, appear annular, like the large worms, though no external indentations are observable; they appear like fine glass tubes filled with water, and containing many air bubbles in close succession, and of the same number as the rings or joints in the old worms. At both extremities (one of which is more sharply pointed than the other), there are no such divisions or joints perceptible. These extremities are each about $\frac{1}{4}$ of the whole length of the worm; they are perfectly transparent, and appear like solid glass.

Respecting the sex of these minute animals, I could never discover any external distinction. The old worms in the same germen are almost every one of a different size; they have all the same proboscis and the same orifices. Three of the seven worms from the same grain which I first examined, were laying their eggs at the same time, though they were not of precisely the same size; but the other four did not; they were considerably smaller, and evidently much

younger; but I have not the least doubt, had they been left undisturbed in the grain, they would, at the proper period, have attained the same size as the others, and would have produced eggs.

This opinion I consider confirmed by my subsequent investigations of grains approaching nearer to maturity; in them there was no such striking difference in size; at that period, the old worms in the same grains, which probably laid their eggs first, were now in a decaying state; some parent worms were found dead, and those still alive were laying eggs, and of the same size as those which I had before observed in the act of discharging their eggs. I also found that the infected germens in the upper part of the ears very frequently contained only one single large worm; notwithstanding which, these germens were gradually filling with eggs, in the same manner as those in which originally there was more than one worm; and among the diseased germens of plants which I had inoculated with the worms and the fungi of the smut-balls, both diseases having taken effect, I found several germens containing only two or three large worms, which formed as many distinct nests within the same germen, having each of them a large distinct cluster of eggs, kept separate by the fungi of the smut-balls that occupied the cavities within those germens.

From all the observations I had an opportunity of making, it appears, that there is no distinction of sex, and that they are true hermaphrodites.

The latter end of July, the diseased grains had almost all attained their full size, and assumed a brownish tint; and about the fifth of August they were all of a dark brown co-

lour, variously distorted, and as hard as wood. The cavities of these grains were now completely filled with young worms, and these worms were, in every respect, the same as those with which I had inoculated my first seed grains; and those specimens were now more than twelve months old, and, consequently, the grains and the worms within them were completely dry; but after soaking them in water about an hour, the worms recovered their powers of moving, and were again as lively as those which were taken from the living plants.

These experiments I repeated with grains from the same specimens, for five years and eight months, always with the same success; but I observed that the longer the grains were kept dry, the longer they required to remain in water before the worms recovered their motion; but after the expiration of five years and eight months the worms were really dead.

The worms of the specimens which were the produce of my inoculated plants, retained their reviviscent quality for six years and one month; and this is the longest time of suspension I have hitherto ascertained; after that time the power of resuscitation ceased.

The large worms, after they become dry, die, and never revive; neither can the young worms within the eggs be revived, if the eggs have been but for a moment dry before the worms have extricated themselves.

Experiments with such worms as had been revived in water before, and had been dried again, I repeated many times; I soon found that those which had been kept the shortest time in water, recovered their motions soonest; so that those which had been examined on the plain object-glass where

only a very small quantity of water can be applied, which very soon evaporates, almost every individual worm recovered in less than a quarter of an hour; and if the water is a second time suffered soon to evaporate, the experiment may be repeated many times successfully with the same worms; but after the second or third repetition, if there is a suspension of a week or ten days at each interval, several worms do not revive, and the number of these increases at every succeeding repetition. If this experiment be not repeated too soon or too frequently, the worms retain their reviviscent quality much longer; the longest period of recovery, after a second suspension, I have hitherto ascertained, was eight months.

If the worms are kept alive in water for a week or ten days, the experiment cannot be repeated so often; but the intervals of suspension may be prolonged considerably. I made the experiment very recently with grains which were three years and ten days old, and dry. After extracting the worms from the grains, I kept them in water thirty-five days, and after they had again been fifteen days perfectly dry, I supplied them with water, and in less than twelve hours soaking they were again, almost every individual, in as lively motion as if they had just been taken from fresh grains of the growing plant. I had the pleasure of showing these worms, in that state, to several Members of the Society, on the 29th of September last; after that day, I preserved the same specimens eighteen days, perfectly dry; when, supplying them with water, I found, in less than three hours, at least one-third of them in lively motion; but the next morning,

after they had just been sixteen hours in water, they were all dead.

If these worms are kept in a large glass, where the water cannot evaporate, they remain alive more than three months, but then they gradually die, and become as straight as needles; in that state they remain unaltered in size and shape, for more than fourteen months; and even after that time I found only a few floating on the surface of the water, in a state of decay; they were then much thinner than they had originally been, and were shrivelled at all their joints, the number of which could now be distinctly ascertained; the worms then assume a brownish colour, and at the least touch, or the slightest agitation of the water in which they are kept, they fall to pieces almost at every joint.

If the worms of one grain are put into water in a watch glass, they generally separate, and spread over a surface of about an inch in diameter, but during night, or if kept some hours in a dark place, they all assemble again, and entwine themselves together in a round cluster, the same as they originally formed within the cavity of the grain; the same glutinous substance by which they were cemented together whilst within the grain, surrounds and envelopes them again; and if they are suffered to get dry in that state, they retain their reviviscent property for as long a time as if they had been preserved within the grain.

The above mentioned glutinous substance appears to be of an oily nature, for if a cluster of the worms be extracted from the grains, and be slightly rubbed on the object-glass, it leaves a stain on the glass, which, if viewed through the

microscope, appears to consist entirely of a clear and colourless fluid, which neither evaporates nor dries on the glass after several months; but if the cemented mass of worms is immersed in water, the clear fluid almost instantaneously dissolves, and the worms separate.

If the worms are kept in a considerable quantity of water, and the water is frequently changed, the worms very soon die in the water, or if taken out whilst yet alive, and suffered to dry on the glass, they remain dead; but if the young worms are kept only in a moderate quantity of water in a watch-glass, the mucus, or glutinous substance, rises, and, in about twelve hours, forms a film on the surface of the water, and soon becomes nearly opaque, and sinks again upon the worms at the bottom of the glass, and in that state the worms continue alive more than two months; but if that film be carefully scummed off, the worms in the water die in less than twelve hours.

This glutinous substance must be secreted by the worms; since in grains in which the worms and the fungi or smut-balls exist, that portion of the cellular tissue of the young germens, where a worm has formed its nest and laid its eggs, is entirely preserved; whilst in those portions of the grains which are immediately in contact with the fungi, the cellular tissue entirely disappears, and the fungi are only enveloped by the external tunic of the young germen.

From these facts, we are to consider this glutinous substance as the probable cause of preserving these minute animals for such a length of time. What is recorded of the shell-snail, which can, by its own mucus, hermetically seal itself for thirty years in its shell against a wall, is similar to this: when

the mucus is dissolved, the air in the lungs is rarified, and forces its way out, so that fresh air rushes into the lungs, and it recovers.

I must however state, that this mucus continues to exist in grains of wheat now more than twenty years old, though the worms within them have, more than twelve years ago, lost their reviviscent quality; but whether length of time can, or cannot, effect such chemical change in the nature of that mucus, and by what means it has lost this preserving power, I must leave for others to decide.

Since writing these observations, I find that a great deal has been written on the subject by authors of eminence, and I have had an opportunity of reading the works of the un-dermentioned writers.* After an attentive perusal of their

* TURBÉVILLE NEEDHAM appears to have been the first discoverer of this extraordinary animal. In his "Microscopical Observations on the Worms discovered in "Smutty Corn," published in 1744, in the XLII. volume of the Philosophical Transactions; and in a small volume, under the title of "An Account of some New Microscopical Discoveries," &c. &c. published in London, 1745, he most correctly describes these worms, and their economy, illustrating his description by very correct figures; yet, in a subsequent publication, he most unaccountably retracts every thing he had before stated respecting them, and declares the white fibrous substance to be true zoophytes.

MAURICE ROYERD, in his "Mémoire sur l'Origine des petits Vers ou Anguilles "du Bled Rachitique" published in the 5th volume of the Journal de Physique, 1775, has also written fully on this subject. He seems to have attentively observed the whole economy and peculiarities of these minute animals, in all the stages of their existence, but fell into a very great error, mistaking worms found in the stalk of a sickly young plant of wheat, for the same as those with which he had inoculated his seed grains. The worms he found, constitute a distinct disease in corn, a detailed account of which, with illustrations, is among my original drawings of all the diseases in corn, now deposited in the Banksian Library. In the same 5th volume of the Journal de Physique, page 197, ROYERD published a second memoir on

observations, I feel great satisfaction in finding that I have nothing to add, nor any alterations to make, in my own investigations and illustrations.

EXPLANATION OF PLATES.

PLATE I.

Fig. 1. A full grown diseased ear of white wheat, natural size.

Fig. 2. A single spiket of an unripe diseased ear in a green state; magnified 5 diameters.

Fig. 3. An infected young germen from the upper part of the green spiket; magnified 10 diameters.

Fig. 4. Transverse section of the same, with one single large worm in its cavity, but no eggs, magnified 10 diameters.

Fig. 5. An infected young germen from the lower part of the same green spiket; magnified 10 diameters.

the same subject, in which he does not offer any new facts respecting these worms, except that he successfully inoculated them upon grains of rye and barley. In the 7th volume of the *Journal de Physique*, published in 1776, page 369, ROFFREDI gives a third memoir on the subject, chiefly intended to clear up the confusion occasioned by many authors giving a different name to the same disease.

In the 7th volume of the *Journal de Physique*, published in 1776, page 43, FELIX FONTANA gives a long letter on the subject of these worms; but his chief object is, to establish two most erroneous ideas; first, he maintains that the infected grains in which the worms are found, are extraneous tumors, or gall-nuts, the mere produce of the worms; this, however, to every one who has seen one of the infected grains, must appear totally at variance with the fact. Secondly, that the suspension of the muscular motions of these worms, which is extended to such extraordinary length of time, is not a state of torpor, but real death, and extinction of life; that the worms really die as often as they get dry, and are again brought to real life, as often as they are moistened with water.

Fig. 6. Transverse section of the same, having one worm and many eggs in its cavity; magnified 10 diameters.

Fig. 7. An infected young germen in a more advanced state; magnified 10 diameters.

Fig. 8. Transverse section of the same, having several large worms, a great many eggs, and some young worms in its cavity; magnified 10 diameters.

Fig. 9. An infected and considerably distorted germen at its full size; magnified 10 diameters.

Fig. 10. Transverse section of the same, its cavity entirely filled with young worms; magnified 10 diameters.

Fig. 11. A single spiket of the ripe ear, containing four infected grains; magnified 10 diameters.

Fig. 12. One of the infected grains of the upper valves of the same spiket; magnified 10 diameters.

Fig. 13. Transverse section of the same, containing in its cavity young worms only; magnified 10 diameters.

Fig. 14. The uppermost, and smallest infected grain of the same spiket; magnified 10 diameters.

Fig. 15. Transverse section of the same; magnified 10 diameters.

Fig. 16. The lowermost and largest infected grain from the same spiket; it is nearly divided into two lobes and two cavities; magnified 10 diameters.

Fig. 17. Transverse section of the same; magnified 10 diameters.

Fig. 18. The infected grain next in order to the preceding one, on the same spiket; magnified 10 diameters.

Fig. 19. Transverse section of the same; magnified 10 diameters.

Fig. 20. An infected grain, the plant of which had been inoculated with the worms, and the uredo foetida, or smut-balls, and both diseases had taken effect; magnified 10 diameters.

Fig. 21. Transverse section of the same; containing in its cavity some large worms, many eggs in distinct clusters, and the rest filled with uredo foetida, or smut-balls; magnified 10 diameters.

Fig. 22. Two infected grains found in one and the same valve of an ear, the seed of which plant had likewise been inoculated with both diseases; one grain, A, is infected with the worms and the uredo, and the other with the uredo foetida only, see B, therefore a true smut-ball; each of these grains has the two rudiments of the pistils at their summits; magnified 10 diameters.

Fig. 23. Transverse section of the same. In the cavity of the grain A, are two large worms, and many eggs in two distinct clusters, and the rest of the cavity is filled with the uredo, and the cavity of the other grain, B, is filled with the uredo foetida only; magnified 10 diameters.

PLATE II.

Fig. 1. A group of worms in water, as seen in the field of the microscope. At A, is one of the largest worms in its most usual attitude, and in the act of laying its eggs; at B, is one of the smallest old worms; at C, D, E, F, and G, is represented the manner of a young worm extricating itself from the egg; at H, is the empty egg-shell; at I, is a dead worm; the rest are worms, bending and twisting themselves

in their most usual attitudes; besides some eggs full and some empty; magnified 100 diameters. Fig. 2. At A, is an egg containing a living young worm, twisted and rolled up in its natural manner; at B, is an egg from which the worm has recently issued; at C, is a decaying and shriveling egg; at D, D, D, are young worms; at E, is a dead worm, stretched out as is always the case; at F, is a dead worm, which had been kept 14 months in water, and only then just began to decay. All the objects of this figure are magnified 200 diameters.

Fig. 3. Transverse section of the same. In the cavity of the grain A are two large worms and many eggs in two distinct clusters, and the rest of the cavity is filled with the mucus, and the cavity of the other grain B is filled with the mucus only; magnified 10 diameters.

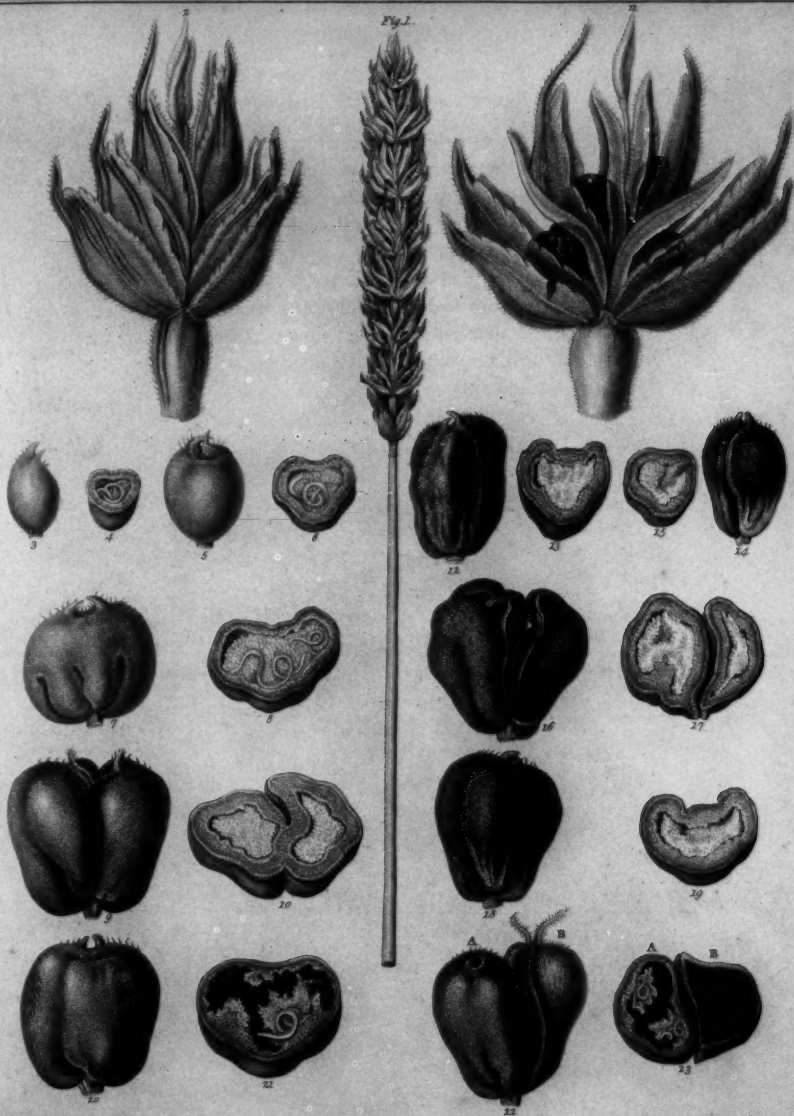
Fig. 4. A group of worms in water, as seen in the field of the microscope. At A is one of the largest worms in its most usual attitude, and in the act of laying its eggs; at B is one of the smallest old worms; at C, D, E, F, and G, is a young worm extricating itself from the egg; at H is the empty egg-shell; at I is a dead worm; the rest are worms, bending and twisting themselves

PLATE II.

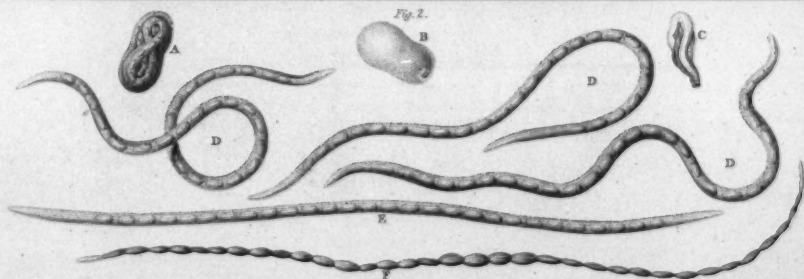
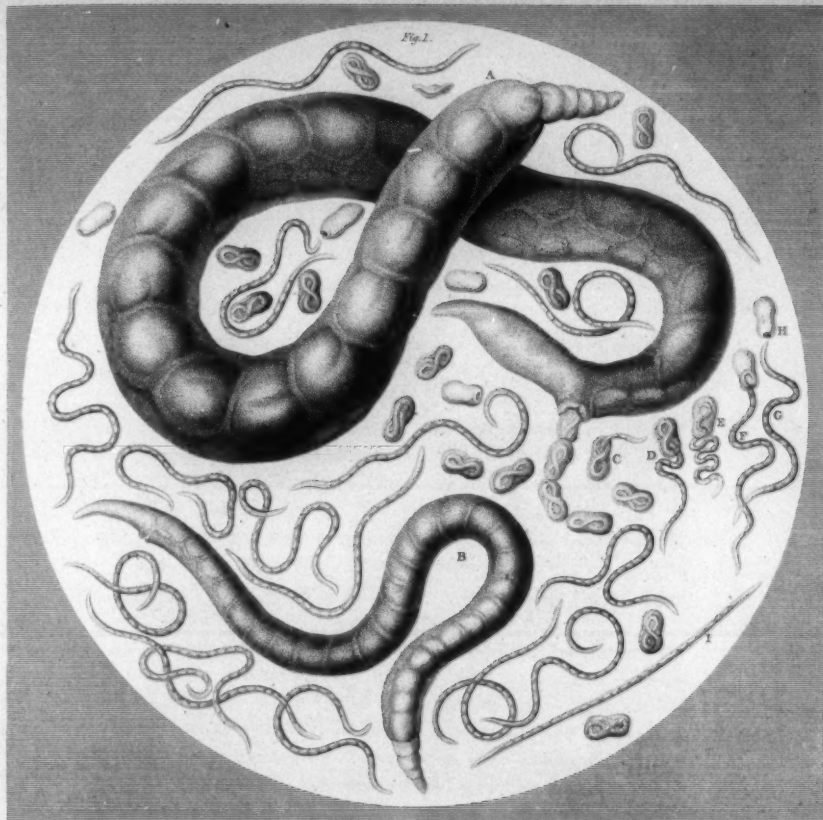
Fig. 1. A group of worms in water, as seen in the field of the microscope. At A is one of the largest worms in its most usual attitude, and in the act of laying its eggs; at B is one of the smallest old worms; at C, D, E, F, and G, is a young worm extricating itself from the egg; at H is the empty egg-shell; at I is a dead worm; the rest are worms, bending and twisting themselves

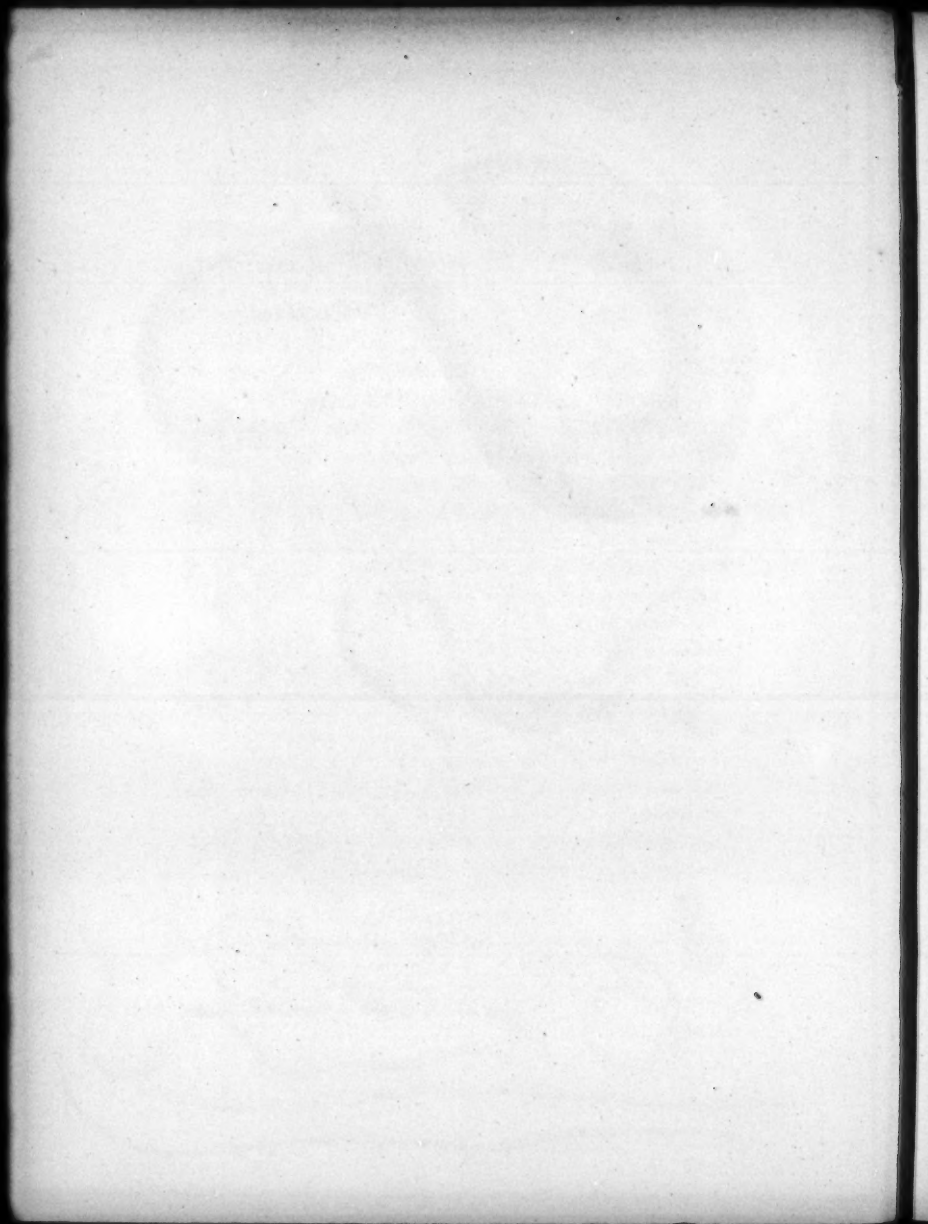


Fig. 1.









II. On Metallic Titanium. By W. H. WOLLASTON, M. D.
V. P. R. S.

Read December 12, 1822.

THE evidence that we yet possess of the reduction of titanium to its metallic state, is not altogether satisfactory; for even LAUGIER, (who has described a valuable series of experiments made upon it in 1814, and who had the advantage of all the previous knowledge acquired by the labours of VAUQUELIN and HECHT, in 1796, of LOWITZ, in 1798, and of LAMPADIUS, in 1803), could only say that he thought himself justified in considering certain parts of his product which were of a golden colour as really reduced; adding in confirmation, that Messrs. VAUQUELIN and HAUY, to whom he had shown them, "appeared disposed to adopt his opinion."

As M. LAUGIER had not the means of confirming his opinion by analysis, I may presume that an account of some experiments which I have recently made upon this substance, will be acceptable to chemists in general; and that in proportion to the degree of doubt they may entertain, they will feel interested to examine scrupulously the evidence I shall adduce as to the metallic state of the subject of my experiments.

* Je me crois fondé à regarder cette couche mamelonnée comme la portion réellement réduite.

M. Y. VAUQUELIN et HAUY m'ont paru disposées à adopter cette opinion.

Ann. de Chimie, V. 29, p. 317.

My attention has been directed, by various friends, especially by Professor BUCKLAND, who gave me the subject of my experiments, to certain very small cubes, having the lustre of burnished copper, that occasionally are found in the slag of the great iron-works at Merthyr Tydvil, in Wales, which, from their hue, have, by some persons, been imagined to be pyritical. Their colour, however, is not truly that of any sulphuret of iron that I have seen; and though the form be cubic, it is not the striated cube of common iron pyrites, which so often passes into the pentagonal dodecahedron, but similar to that of common salt; for any marks, that are to be discerned on their surfaces, appear as indented squares instead of striae.

Their hardness also is totally different from that of pyrites, and is such as, when combined with the preceding characters, marks a substance wholly unknown to mineralogists. By selecting a sharp angle of one of these cubes, I found that I could not only write upon the hardest steel, or upon crown glass, but could even visibly scratch a polished surface of agate or rock crystal.

Having broken out some of these crystals for experiment, I found them all apparently attracted by a magnet; but observing that they had still small portions of slag adherent to them, they were next digested in muriatic acid, which, by dissolving the iron from their surfaces, soon freed them from their deceptive appearance of magnetism.

The cubes thus purified are not acted upon by muriatic acid.

Nitric acid has no action upon them.

Nitro-muriatic acid does not dissolve them.

Boiling sulphuric acid does not affect them.

Before the blow-pipe they are utterly infusible. A con-

tinued heat oxidates them, and they become purple or red at the surface, according to the degree of oxidation, or depth to which it penetrates.

Borax has no action upon them, but only cleans the surface from any oxide that may be formed. Neither does the addition of subcarbonate of soda produce more effect than borax alone.

Nitre, aided by a strong heat, oxidates them rapidly; but unless the heat be long continued, the effect is only superficial.

The combined action of nitre and borax together, soon effects their solution, as the latter dissolves the oxide as fast as it is formed, and presents a clean surface for fresh oxidation. But as these salts do not unite by fusion, the addition of soda, as a medium of union, considerably shortens the process. The fused mass becomes opaque in cooling, by the deposit of a white oxide, which may either be previously freed of the salts by boiling water and then dissolved in muriatic acid, or the whole mass may be at once dissolved together.

In either case alkalies precipitate from the solution a white oxide, which is not soluble by excess of alkali, either pure, or in the state of carbonate. By evaporating the muriatic solution of the oxide to dryness, at the heat of boiling water, it is freed of any redundant acid, and the muriate which remains is perfectly soluble in water, and in a state most favourable for exhibiting the characteristic properties of the metal.

Infusion of galls gives the well known colour of gallate of titanium. The colour occasioned by adding triple prussiate of potash is red, as observed by LAUGIER, and so nearly re-

resembling that of the gallate, that I do not think any difference that I can discern is to be depended upon as constant. It differs from prussiate of copper by inclining to orange instead of purple; while the colour of prussiate of uranium is rather brown than red.

Since the oxide thus examined agrees in its characteristic properties with that of titanium procured from Anatase, I cannot entertain a doubt as to the general nature of the substance under consideration. I believe it to be pure, for I find no trace of any other substance combined with it, not even of iron, although the crystals are found imbedded in an iron slag, in the presence of metallic iron; nor yet of silica, for which the oxide has a strong affinity. Neither is there any sulphur present, as the salt which remains after oxidation of it by nitre, contains no trace of sulphuric acid.

That the cubes are in the metallic state, is nearly proved by their lustre, by the effect of nitre upon them, and by the failure of borax to act upon them, till they have been subjected to the action of nitre. It may be farther observed, that, when the action of nitre is rapid, heat is evidently generated, as by the combustion of other metals; but as I acted upon them in their solid state, and did not pulverise them, I did not witness what could properly be called detonation, as described by LAMPADIUS.

The property which may be regarded as most decisive of the metallic state of these cubes, is the power which I find them to possess of perfectly conducting the most feeble electricity.

If a slip of zinc and another of copper be placed in contact, and immersed together in dilute sulphuric acid, bubbles of

gas are seen to rise from the surfaces of both the metals; but, if a piece of paper be interposed between them, then no gas is given off by the copper. In a piece of paper, so placed between zinc and copper, I made a small hole, and after inserting in it one of the cubes so as to be in contact with both the metals, I had the satisfaction to find an electric communication completely established by this interposition, for gas was now given off from the surface of the copper.

From the situation in which this metal is found, it evidently has no affinity for iron in the metallic state, and it seems equally indisposed to unite with every other metal that I have tried. Though it is evidently impossible to measure with precision the specific gravity of such specimens as I first received for analysis, I was in hopes of trying whether one of the largest of the cubes would sink or swim in melted tin, and for that purpose endeavoured to tin its surface, but I could not succeed in uniting it with either tin or lead, with silver or copper, and had no encouragement to prosecute farther a series of negative results, in search of metals for which it may have an affinity.

From the extreme infusibility of these cubes, it seems probable that they have not been formed by crystallization in cooling from a state of fusion, but have received their successive increments by reduction of the oxide dissolved in the slag around them: a mode of formation to which we must have recourse for conceiving rightly the formation in nature of many other metallic crystals.

Since the date of this communication, the liberality of Mr. ANTHONY HILL, of Merthyr Tydvil, has supplied me with a

larger quantity of the slag which formed the subject of my first experiments, and has enabled me to determine the specific gravity of metallic titanium to be 5.9. For this purpose, the vitreous part was fused with a mixture of borax and sub-carbonate of soda in about equal quantities, and was then dissolved in muriatic acid, which also removed a quantity of metallic iron, and left the titanium freed from extraneous matter. Though great part of what was thus obtained from the interior of the slag was in a pulverulent state, the quantity, which amounted to 32 grains, and displaced 6.04 of water, was sufficient to preclude any considerable error.

I have moreover learned that metallic cubes, similar to those which I have above described and examined, were, more than 20 years since, observed in a slag at the Clyde iron-works in Scotland; that a small quantity has also been met with at the Low Moor iron-works, near Bradford, in Yorkshire; and at the Pidding iron-works, near Alfreton, in Derbyshire; and that some good specimens have been obtained from Ponty-pool, in Monmouthshire; but it does not appear that any one has ascertained, or even suspected, the real nature of this singular product.

III. *On the difference of structure between the human Membrana Tympani and that of the Elephant.* By Sir EVERARD HOME, Bart. V. P. R. S.

Read December 12, 1822.

IN the year 1799, I brought before the Society proofs of muscularity in the membrana tympani of the elephant, and led on by that discovery, I was enabled to show that this membrane in the human ear is also muscular.

As the organ I examined in the elephant was in a dried state, and the parts somewhat distorted, I went no farther than to state, that the form of the membrane was oval; the fibres, as in the human ear, radiated from the circumference to the centre, and instead of being attached to the point of the handle of the malleus, were connected to it through its whole length: that this oval form, common to many quadrupeds, as the horse, deer, and cat, was the probable cause of these animals not having their ears adapted to musical sounds, in the same degree with man, whose membrane is circular, all the muscular fibres forming radii of equal lengths from the centre to the circumference. Ever since that time, I have put my friends, in the different parts of India, under contribution to supply me with the head of a young elephant preserved in spirit, to enable me, with more accuracy, to examine the fibres of the membrana tympani.

In this object I have at last succeeded, through the kindness

of Sir STAMFORD RAFFLES, whose exertions in collecting specimens of natural history, as they are beyond all example, so they are above my praise; they are known to this Society, and there is no doubt, that many new opportunities will occur of their being recorded in the Philosophical Transactions.

The elephant was only three weeks old, and one ear has the membrana tympani in a perfect state, and in its natural situation. It is of an oval form, one inch and half long, one inch $\frac{1}{4}$ broad; the muscular fibres lie upon the inner surface of the membrane; the handle of the malleus lies transversely, and passes in the direction of one of the foci of the oval; it terminates in the centre of that focus; the muscular fibres not only terminate by an attachment to the point, but are connected to the two sides. From this arrangement, one portion of the fibres is short, the other more than double their length; this will be better understood by the annexed drawing.

So great a difference in the form and structure of this membrane in the elephant, from that of the human ear, makes it obvious that this animal cannot adapt its ear to musical sounds in the same manner the human ear does, the fibres being of such different lengths; it became therefore a consideration, what purpose was answered by such a disproportion in the length of the fibres.

Having heard from my friend Mr. CORSE, who had attended to the habits of the elephant, that they heard sounds at a great distance, an instance of which, respecting the call of the young, is inserted in my former paper, I was induced to believe that the long fibres answered that purpose.

To see the effect of high and low notes upon the elephant

in Exeter 'Change, Mr. BROADWOOD kindly sent one of his tuners with a piano-forte to make the experiment: the higher notes hardly attracted notice, but the low ones called up the elephant's attention. He brought his broad ears forward, remained evidently listening, and he made use of sounds rather expressive of satisfaction than otherwise.

The full sound of the French horn produced the same effect.

The nearest approach I have met with among quadrupeds to this peculiarity in the elephant, is in neat cattle: in them the membrane is more oval proportionably than in the elephant; it is $\frac{1}{20}$ of an inch long, $\frac{1}{30}$ broad. The handle of the malleus lies in the direction of the transverse diameter of the oval, and extends $\frac{2}{3}$ of its length: it is not, however, situated in the middle line of the oval, but so much nearer to the anterior side, that the fibres on that side are $\frac{2}{3}$ shorter than those on the opposite.

In the deer, the membrane is of an oval form, whose transverse diameter is $\frac{1}{20}$ of an inch, the conjugate $\frac{1}{30}$: the malleus has its handle nearer the middle line than in neat cattle, the anterior fibres are $\frac{2}{30}$ of an inch, the posterior $\frac{1}{30}$ of an inch long. This is seen in the drawings. [Plate V.]

In the horse, and hare, the handle of the malleus lies in the middle line, so that the fibres on the two sides are equal. In the hare, the handle is more curved. See the drawing. [Plate V.]

In the cat, the fibres are nearly the same as in the horse. I mention this circumstance, since it leads to the conclusion, that the whole of the feline kind have a similarly constructed organ.

The effect of the high notes of the piano-forte upon the great lion in Exeter 'Change, only called his attention, which was very great. He remained silent and motionless; but no sooner were the flat notes sounded, than he sprung up, endeavoured to break loose, lashed his tail, and appeared to be enraged and furious, so much so as to alarm the female spectators. This was accompanied with the deepest yells, which ceased with the music.

EXPLANATION OF THE PLATES.

PLATE III. The membrana tympani.

Fig. 1. Human Membrana tympani; natural size.

Fig. 2. Ditto magnified.

Fig. 3. Ditto in the elephant; natural size.

PLATE IV. Membrana tympani in situ; and mastoid cells, of the elephant.

PLATE V. The membrana tympani.

Fig. 1. In neat cattle; natural size.

Fig. 2. Ditto magnified.

Fig. 3. In the deer; natural size.

Fig. 4. Ditto magnified.

Fig. 5. In the hare; natural size.

Fig. 6. Ditto magnified.

Fig. 2.

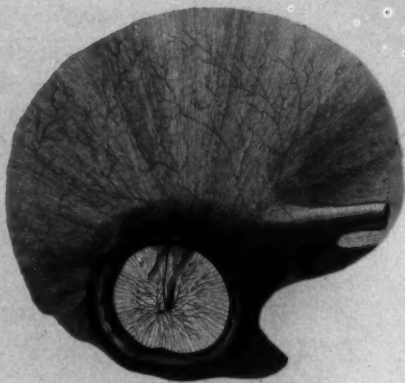


Fig. 2.

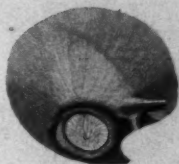
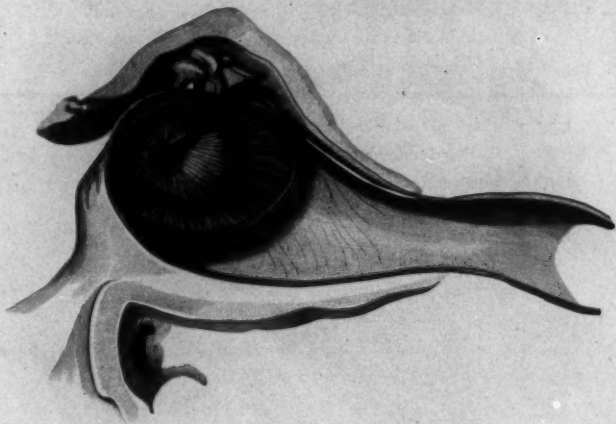


Fig. 3.







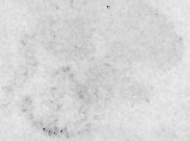
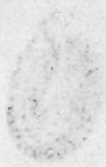
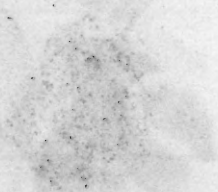
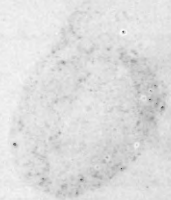
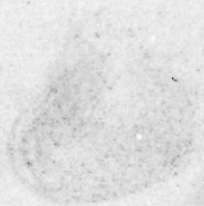


Fig. 1.

COW.



2



3

DEER.



4



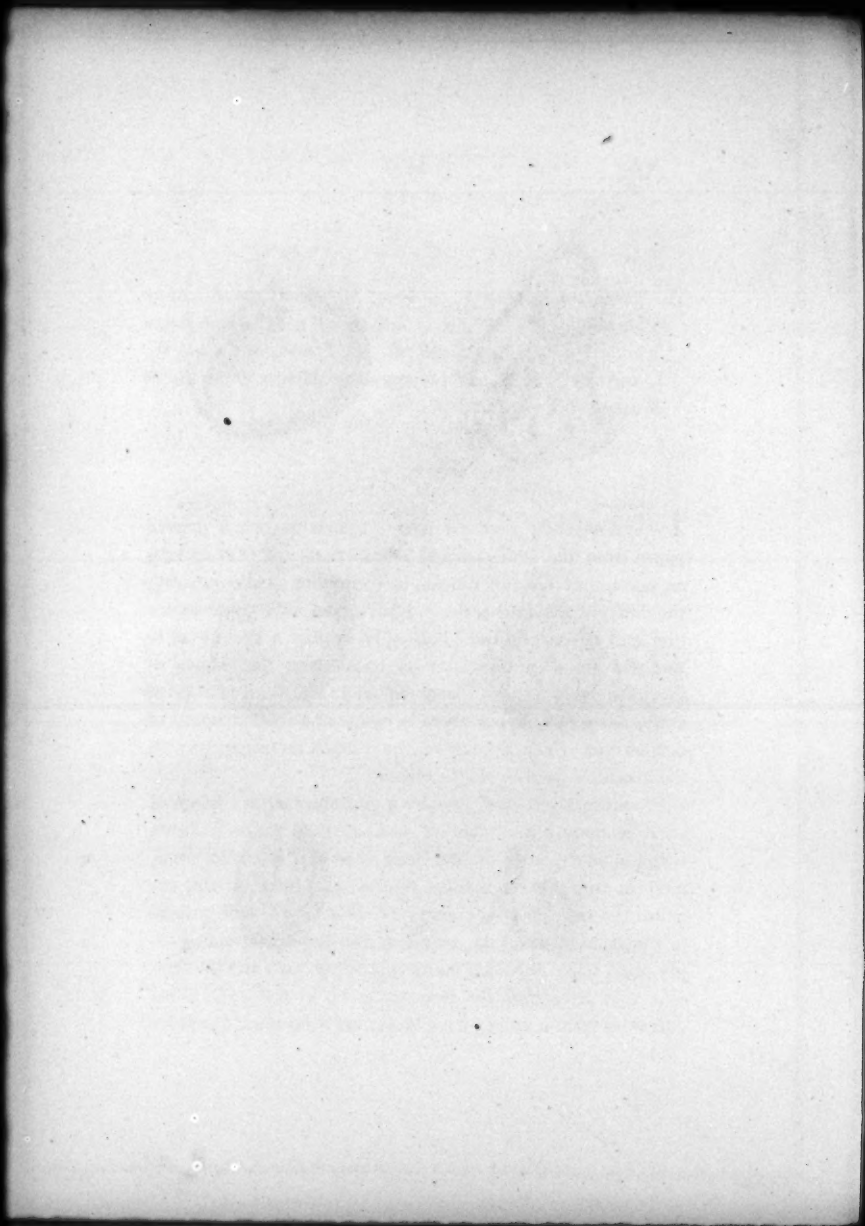
5

HARE.



6





IV. *Corrections applied to the Great Meridional Arc, extending from latitude $8^{\circ} 9' 38''$, 39, to latitude $18^{\circ} 3' 23''$, 64, to reduce it to the Parliamentary Standard. By Lieutenant Colonel W. LAMBTON, F. R. S. and Corresponding Member of the Royal Academy of Sciences at Paris.*

Read January 9, 1823.

I HAVE recently received from Captain KATER a printed paper from the Philosophical Transactions for 1821, giving an account of his experiments in examining and comparing the different standard scales. I have read with great attention and satisfaction the whole of his results, and am glad to find that the Commissioners for considering the subject of weights and measures, have adopted Mr. BIRD's scale of 1760, as by that means there is now a universal standard of comparison, which applies to the French metre, and to all the measures used on the Continent.

From Captain KATER's results it appears, that my standard scale requires a multiplier of $-.000018$ to make it agree with the above scale of Mr. BIRD; and that RAMSDEN's bar, used in the Trigonometrical Survey of Great Britain, requires the multiplier $+.00007$. That is to say, with respect to a measurement on the meridian, the degree depending on my brass scale must be multiplied by, $.000018$ and the product subtracted from the measure given by the scale, to reduce it to what it would have been, had it been measured by

what is now the parliamentary standard ; and the degree depending on RAMSDEN's bar, must be multiplied by ,00007, and the product added to the measure given by the bar, to reduce it to the standard measure.

Now the arc which I have measured depends on both these standards, as I had a new chain sent out by Mr. BERGE in 1802, which was laid off from RAMSDEN's bar at the temperature of 52° ; and this chain has never been used as a measuring chain, but as a standard chain with which to compare the other, till after the base near Gooty was measured, when the irregularity in the wear of the measuring chain was first discovered ; for then the brass standard *scale* was had recourse to, and a correction applied to the base ; and the triangles computed back to Yerracondah, one of the meridional stations about half way between the base near Bangalore and that near Gooty : and this is the correction alluded to in page 487 in the second part of the Philosophical Transactions for 1818. It thence follows, that the meridional distance from Yerracondah to Daumergidda depends on the brass standard *scale* ; and that the meridional distance from Yerracondah to Punnae, near Cape Comorin, depends on the standard *chain*.

I shall now proceed to give the different sections of the arc, correcting them by the above factors as I go along.

From Namthabad back to Yerracondah, by the	Feet.
base, as measured in 1811.	429120,6 s.
The same distance by the corrected base, is	429134,3 s.
Hence, from Namthabad to Yerracondah, depending on the standard <i>scale</i> , is	429134,3 s.
From Yerracondah to Dodagoontah, depending on the standard <i>chain</i> , is	332662,8 s.

From Dodagoontah to Putchapolliam, depending	Fath.
on the standard <i>chain</i> , is - - -	727334, s.
These three being corrected by their respective	
factors, we shall have the meridional dis-	
tance from Namthabad to Yerracondah -	429196,6 s.
From Yerracondah to Dodagoontah -	332685,6 s.
From Dodagoontah to Putchapolliam -	727385,5 s.
From Namthabad to Putchapolliam -	1489197,7 s.
or Fathoms	248199,6 s.

Now the celestial arc between Namthabad and Putchapolliam is $4^{\circ} 6' 11''$, $28 = 4^{\circ} 10313$.

Fathoms.

Hence $\frac{248199,6}{4^{\circ} 10313} = 60490,31$ the degree due to $13^{\circ} 2' 55''$, the middle point.

Then from Putchapolliam to Punnae, depending on the standard *chain*, is - - -

Fathoms.

171516,75 s.

Which, corrected by its multiplier, is - - - 171528,76 s.

And the celestial arc, is $2^{\circ} 50' 10''$, $54 = 2^{\circ} 83626$

Hence $\frac{171528,76}{2^{\circ} 83626} = 60477,09$ fathoms, the degree due to $9^{\circ} 34' 44''$ the middle point.

Then from Namthabad to Daumergidda, depending on the standard *scale*, is - - -

178904,7

Which, corrected by its multiplier, is - - - 178901,48

The celestial arc is $2^{\circ} 57' 23'' = 2^{\circ} 95648$

Hence $\frac{178901,48}{2^{\circ} 95648} = 60511,65$ fathoms, the degree due to $16^{\circ} 34' 42''$ the middle point. From

which we have the degrees as follows:

The degree for latitude $9^{\circ} 34' 44'' = 60477,09$
 for latitude $13^{\circ} 2' 55'' = 60490,31$
 for latitude $16^{\circ} 34' 42'' = 60511,65$ } Indian.

Fathoms.

Fathoms.

The degree for latitude $47^{\circ} 50' 46'' = 60779,00$ French.for latitude $52^{\circ} 20' = 60824,26$ English.for latitude $66^{\circ} 20' 12'' = 60955,00$ Swedish.

Then computing from Eq. 3, page 498, in the Philosophical Transactions for 1818, 2d. Part, we shall have the ellipticity of the earth as follows :

By the Indian and French $\frac{1}{310,07}$; $\frac{1}{309,64}$; $\frac{1}{313,73}$; Mean $\frac{1}{311,15}$

By the Indian and English $\frac{1}{310,3}$; $\frac{1}{309,94}$; $\frac{1}{313,72}$; . . . $\frac{1}{311,32}$

By the Indian and Swedish $\frac{1}{307,88}$; $\frac{1}{307,55}$; $\frac{1}{309,92}$; . . . $\frac{1}{308,45}$

General Mean $\frac{1}{310,31}$

Now half the terrestrial arc between Putchapolliam and Punnae, is - - - - - 85764,38

To which add half a degree south, or - - - 50238,54

Their sum is the terrestrial arc between Putchapolliam and half a degree south of the middle point - - - - - 116002,92

The latitude of half a degree south of the middle point, is $9^{\circ} 4' 44''$, or more correctly $9^{\circ} 4' 43'',66$, which is the latitude of the south extremity of an arc of complete degrees.

Now the terrestrial arc between Putchapolliam and Namthabad, is - - - - - 248199,62

And between Namthabad and Daumergidda - 178901,48

The sum of these *three* arcs is the terrestrial arc between latitude $9^{\circ} 4' 44''$ and Daumergidda 548104,02

The latitude of Daumergidda is $18^{\circ} 3' 23'',58$

From which subtract - - - 9 4 43 ,66

Their difference or arc = - - - $8^{\circ} 58' 39''.93$ whose measure is - 543104,02
 To which add - - - $0^{\circ} 1' 20''.08$ whose measure is - 1346,08

Gives the No. (n) of complete degrees = 9 0 0,00 whose measure (A) = 544450,10

Then, referring to page 509 Philosophical Transactions for

1818, Part II., we have $n = 9$; $A = 544450,1$; $a = (\sin^{(2)} l)$

$-\sin^{(1)} l = ,006042$; $b = (\sin^{(2)} l - \sin^{(1)} l) + (\sin^{(3)} l$

$-\sin^{(1)} l) + \&c. = ,263137$; $m' = \frac{310,31 \cdot A}{36 + 310,31 \cdot n} = 60477,76$;

$A - nm' = 150,26$; $d = (A - m'n) \cdot \frac{a}{b} = 3,45$ and $Q = 571$ nearly.

From which the following Table has been computed; and it appears from *this table*, that the first degree in latitude $9^{\circ} 34' 44''$ by the measurement is 0,87 fathoms in defect; and that the degree in latitude $16^{\circ} 34' 42''$ (which may be taken for $16^{\circ} 34' 44''$) by the measurement is 3,91 fathoms in excess.

TABLE.

	Degrees in Fathoms.	Latitude.
(1) (1) $m = m + 0$ - - - - -	60477,76	9 34 44
(2) (1) $m = m + d$ - - - - -	60481,21	10 34 44
(3) (1) (3) (1) $m = m + Q (\sin^{(3)} l - \sin^{(1)} l)$ - - -	60484,95	11 34 44
(4) (1) (4) (1) $m = m + Q (\sin^{(4)} l - \sin^{(1)} l)$ - - -	60489,03	12 34 44
(5) (1) (5) (1) $m = m + Q (\sin^{(5)} l - \sin^{(1)} l)$ - - -	60493,42	13 34 44
(6) (1) (6) (1) $m = m + Q (\sin^{(6)} l - \sin^{(1)} l)$ - - -	60498,13	14 34 44
(7) (1) (7) (1) $m = m + Q (\sin^{(7)} l - \sin^{(1)} l)$ - - -	60503,13	15 34 44
(8) (1) (8) (1) $m = m + Q (\sin^{(8)} l - \sin^{(1)} l)$ - - -	60508,44	16 34 44
(9) (1) (9) (1) $m = m + Q (\sin^{(9)} l - \sin^{(1)} l)$ - - -	60514,03	17 34 44
Their sum	544450,10 = A	

With respect to the dimensions of the earth, and the length

of the quadrantal arc of the elliptic meridian, let $(1) l = 15^{\circ} 34' 44''$;

$m' = 60493,42$ fathoms, $e = \frac{1}{310,31} = ,0032226$; then $3e$

$= ,0096678$; $3e \cdot \sin^2 (1) l = ,0005329$. Then if m be the

degree on the meridian at the equator, where $\sin. l$ is 0, $m =$

$\frac{m'}{1 + 3e \cdot \sin^2 (1) l} = \frac{60493,42}{1,0005329} = 60461,2$ fathoms, and therefore

$60461,2 \cdot \frac{1 + 3e}{1 + e} = 60850,17$ fathoms, the measure of the de-

gree on the equatorial circle (see the different equations in the Philosophical Transactions for 1818, Part II.)

Put $A = 57^{\circ}$, &c. the arc equal rad: then $Am = 3486457,9$

and therefore $2 \times 3486457,9 = 6972915,8$ fathoms for the

diameter of the equatorial circle; equal the major axis of the

elliptical meridian, which call a . Then if the minor axis be

designated by b , we have $b = (1 - e) a = 6950442$ fathoms

for the polar axis of the spheroid, supposing it to be an el-

lipsoid. But $3,14159$, &c. $\times 6972916 = 21906074$ the cir-

cumference of the circumscribing circle. Then if $d = 1 - \frac{b^2}{a^2}$

$= ,0064355$; we have $1 : 1 - (\frac{d}{a^2} + \frac{3d^2}{2^2 \cdot 4^2}) :: 21906074 :$

21871024 , the length of the elliptic meridian. Hence $\frac{21871024}{4}$

$= 5467756$ is the length of the quadrantal arc, which, reduced

to inches, and multiplied by $10,000000$ we get $39,3677$ in-

ches for the metre at the temperature of 62° , which falls short

of the French metre by $,0032$ inches, when reduced to the

same temperature.

This conclusion is very satisfactory, and I hope that equal

success will attend my operations to the northward. I have

already measured another section, which extends to latitude

$21^{\circ}6'$, having just returned from finishing it; and when all the necessary calculations and corrections are made, I shall draw out an account of the whole, and forward it to the Royal Society at a future period. The celestial arc has been determined by seven stars, but there are many now out of my reach, which I observed in the beginning.

It may be satisfactory to the mathematicians in Europe to know, that I am now advancing through Hindoostan; and, from what I can learn from the different publick authorities, I do not apprehend any difficulty. They are all inviting in their letters, and all seem desirous that I should go through their respective districts. If my present arc be continued direct, it will pass through Bopaul, and near Seronje, where I shall have again to observe the stars and measure a base; and if Scindiah's country be in a quiet state, my meridian will pass near Gualior, his capital; and my sixth section will terminate near Agra, on the Jumna. I have made up my mind to execute all this if I live, and continue to have that flow of health and spirits which have hitherto attended me. The results of such an extensive measurement must be interesting to scientific men; and I shall exert my endeavours in doing justice to the work, and in giving a faithful account of the operations.

V. *On the changes which have taken place in the declination of some of the principal fixed Stars.* By JOHN POND, Esq. Astronomer Royal, F.R.S.

Read April 18, 1822.

THE mural circle having in September last been put into complete repair, and declared by Mr. TRAUGHTON to be in as perfect a state as when first erected, I resumed my examination of the principal fixed Stars which form the Greenwich Catalogue. In the course of a very short time, I found that several anomalies, which had previously given me much perplexity, still subsisted: some of these were of such a nature as to lead to a suspicion that a change might possibly have taken place in the figure of the instrument; on the other hand, there were circumstances, that strongly militated against such a supposition.

Several of the stars in which the supposed discordance appeared the greatest, passed over almost the same divisions with others, in which no such discordance could be perceived. Moreover, in examining these discordances in different points of view (that is, both with respect to their right ascensions and polar distances) I fancied I perceived something like a general law, that was quite incompatible with any possible hypothesis of error in the instrument.

On a point of this importance, I clearly saw the necessity of devising some new method of observation which might

decide with certainty, that which otherwise would become an endless subject of doubt and conjecture.

I had often attempted to observe the altitudes of stars by means of an artificial horizon of quicksilver, or other fluid, but had abandoned the attempt from the difficulty of protecting it from the wind, and from the number of observations I lost in fruitless experiments. To this method I had again recourse; and by means of wooden boxes of different sizes and figures, according to the different altitudes of the stars, I have sufficiently accomplished my purpose. A very few observations were sufficient to convince me that the instrument was in every respect perfect, and that I might repose the greatest confidence in every result it gave.

Several stars, and particularly those most discordant, I have observed by this new method, and find their places, without any exception, to agree within a fraction of a second, with those determined by direct measurement from the pole.

Presuming that the observations* which accompany this paper will remove every shadow of a doubt as to the accuracy of the instrument, I shall now proceed to state, in as few words as possible, the nature of the changes which appear to me to have taken place since the year 1812.

If BRADLEY'S catalogue of stars for the year 1756, be compared with the Greenwich catalogue for 1813, it will be possible to deduce the annual variation for each star for the mean period, or for the year 1784, on the supposition of uniformity in the proper motion of each star; then allowing for the change of precession for each star, a catalogue may

* Vide Appendix.

be computed for any distant period ; as for example, the present year 1822. Suppose such a catalogue computed, which I have named a predicted catalogue ; then, if this be compared with the observed catalogue for the same year, the following differences will be found to subsist between them.

The general tendency of all the stars will be to appear to the south of their predicted places, and this tendency seems to be greater in southern than in northern stars ; if any star be found north of its predicted place, it will always be a star north of the zenith, and the quantity of its motion extremely small. There may be observed a much greater tendency to southern motion in some parts of the heavens than in opposite, or distant parts as to right ascension, and in much the greater portion of the heavens the southern motion seems to prevail. A southern star, as Sirius, situated in that part of the heavens most favourable for southern motion, will be found more to the south of its predicted place than Antares, situated in the part least favourable for southern motion, though it is itself more southward.

Several stars have moved more from their predicted places than other neighbouring stars ; when this happens, the motion is always southward ; I have yet met with no exception to this rule ; not a single star can be found having an *extra* tendency to northern motion ; and indeed the northern motion in any star is so very small, that it would never have excited attention.

A very great deviation will be found in three very bright stars, Capella, Procyon, and Sirius : the proper motion of each of these is southward ; it therefore follows that these proper motions are accelerated. The proper motion of Arc-

turus is very great, and likewise southward. It is situated in that part of the heavens where the southern tendency is least discernible, and is nearly quiescent; its proper motion in polar distance may therefore be considered as uniform. There is a circumstance that deserves notice, though it may be merely accidental: the stars in the Greenwich catalogue, whose proper motions are south, nearly equal in number those that are north, yet the *quantity* of southern proper motion exceeds the northern in the proportion of four to one.

I shall at present offer no conjecture on the cause of these deviations, but endeavour, by continued observations, more accurately to ascertain the law which they follow. Should the weather prove favourable for observation, I hope before the Society separate for the summer, to be able to give greater accuracy to the numbers here subjoined. Indeed I should not have made so early a communication on the subject, but as the Greenwich observations of 1820 are about to be published, they might without this explanation have appeared erroneous; for I find that during that year the instrument was rather defective from general unsteadiness, than from any perceptible deviation of the telescope. It was not till after the month of February, 1821, that the instrument got completely out of repair. It must however be admitted, that the observations of that year ought not to be employed in the determination of such small quantities as form the subject of the present communication.

Horizontal point of the Circle as found by different Stars observed by direct vision and reflection, from 11th to 23rd March, 1822.

<i>h</i> Urs. Maj.	123	30	29,55
<i>v</i>	-	-	28,95
<i>m</i>	-	-	29,75
β	-	-	29,45
<i>a</i>	-	-	29,50
<i>o</i>	-	-	29,05
Castor	-	-	29,85
Capella	-	-	29,55
Pollux	-	-	29,95
β Aurigæ	-	-	29,35
Mean of 10	-	-	29,54
Sirius	-	-	29,47

There being no perceptible difference in the results obtained near the zenith and near the horizon, it may be concluded that the instrument has no deviation, either from flexion of the telescope or change of figure.

VI. *Appendix to the preceding Paper on the changes which appear to have taken place in the declination of some of the fixed Stars.*

By J. POND, Esq. *Astronomer Royal, F. R. S.*

Read November 14, 1822.

THE observations which have been made during the last summer, confirm in a very decided manner the results which formed the subject of my last communication; in which I laid before the Society the nature of the differences that exist between the computed places of the principal Stars of the Greenwich Catalogue, and those deduced from actual observation. It is not my present intention to offer any explanation of the cause of these phenomena, although many obvious conjectures present themselves, the value of which it will require perhaps many years to determine. It is now my principal object to consider the force of that explanation of the differences in question, which will most readily occur to every astronomer, namely, that the whole may arise either from error committed by the observer, or from defect in the instruments of observation: this objection being the more weighty from the circumstance, that the observations of three distant periods are employed, and that an error in those of either period (but particularly of the two latter) would materially affect the result now under consideration.

I believe that every person, in proportion to his experience in the use of astronomical instruments, (even of the most unexceptionable construction), will be cautious in admitting

the accuracy of any results, with whatever care the observations may have been made, which appear to militate against any received theory of astronomy; and I shall have occasion myself to show, from the great discordances between instruments of the highest reputation, that this distrust is but too well founded. More particularly ought our suspicion to be excited, when such anomalies are found to exist, as bear some direct proportion to the zenith distances of the stars observed. In all such cases we should never hesitate, I think, to ascribe the anomalies to defective observation. If therefore in the present instance, any part of the discordances in question can be shown to depend on polar or zenith distances, I shall willingly admit, as to such part of them at least, that they are no otherwise of importance, than as affording data for leading to the detection of some hitherto undiscovered errors. The anomalies, however, that have led me on to this enquiry, and to which alone I attach any importance, are found to depend rather on the right ascensions, than on the declinations of the stars. Accordingly I found, while collecting observations to form a catalogue for the present period, that I could more nearly predict the deviation of a star from its computed place, by knowing its right ascension, than its declination. Now it is not easy to conceive in what way the error of an instrument for measuring declination, fixed in the meridian, can be occasioned by any circumstance depending on the right ascension of a star to be observed.

The general nature of the deviation of the stars from their computed places will be best understood from the annexed tables; in one of which the principal Stars of the Greenwich Catalogue are arranged according to north polar distance, and in the other, in the order of their right ascensions.

From these tables it will appear, according to my statement in the former part of this paper, that the general tendency of the deviation is towards the south: that in about one-third part of the heavens in right ascension this southern tendency is very inconsiderable, and would hardly have excited attention: for in this part, stars between the zenith and the pole, appear a very small quantity to the northward; whereas in the remaining, and most considerable portion of the heavens, every star appears to be a considerable quantity to the south of its computed place; and with few exceptions, the more southward stars have a greater tendency to deviation than the northern ones.

If we select from the preceding tables, those stars which were least frequently observed, at one or all of the three periods, we shall find that they all tend to confirm the foregoing general results; though they must be regarded as doing so, rather by their united effect, than by their weight of evidence when considered singly. Stars that have been but seldom observed, give results considerably affected by accidental error of observation; which error is quite of a different nature from that produced by permanent defect in the instrument, and which repetition of observation has no tendency to remove.

If the deviations of those stars that have been imperfectly observed, were attributable either to error of observation, or defect in the instruments, the deviation would either follow no law at all, or some law depending upon zenith distance: but the facts we have seen to be at variance with either of these hypotheses. Not however to rest satisfied with these considerations drawn from the general tendency of all the stars

without exception, let us select some striking examples of deviation, in particular groups of stars, on which we might be satisfied to rest the issue of this question. Of these groups I have marked *five*, in the table of stars arranged according to north-polar distance, each of which we will take the pains to consider more attentively.

1. There are six stars in my Catalogue north of γ Draconis, of which three are found to the north, and three to the south of their computed places. These inequalities may appear at first sight to be wholly accidental; but if we pay attention to the right ascension, we shall find that the three which appear to the northward, are situated in that part of the heavens as to right ascension where the southern deviation is the least perceptible, and that the three which appear to the southward, are in that part as to right ascension where the southern deviation is the greatest. But of these six stars there are two, α Cassiopeiae, and γ Ursae Majoris, which deserve farther consideration. These two stars are within less than one degree of each other in polar distance, and consequently pass over the meridian at nearly the same altitude. The observations of BRADLEY on the stars north of the zenith are not so numerous as could be wished; but each of the two stars in question was observed by him about five times towards the year 1753; that is 60 years from the date of my catalogue of 1813. I have carefully recomputed the predicted places of these stars, and I find α Cassiopeiae not less than $1''.5$ to the south of its predicted place, and γ Ursae Majoris half a second to the north. Now I am quite at a loss to conceive how this difference in so small an arc can arise from error of observation, and I can only attribute it to that cause, whatever it may be, which

seems so generally to depend not on the polar distance, but on the right ascension of the star:

2. The second group which I shall consider, contains the stars α Arietis, Arcturus, and Aldebaran, comprehended within an arc of about six degrees and a half. Of these three, Arcturus alone has yet been observed by reflection; but from the present very perfect state of the Greenwich circle, which the method of reflection has enabled me to ascertain, it cannot be doubted that the places of the two other stars are well determined.* In Arcturus the southern deviation is nearly insensible, but in the two other stars it is very considerable, being in each not less than $1''.5$. Now these three stars, but particularly the two latter, are among those that have been most assiduously observed by BRADLEY and myself, at each of the three periods. Let us suppose then, if it be possible, that the whole of these deviations arise from error of observation; or in other words, that no systematic deviation has really taken place in the stars, but that their proper motions are uniform. Then we must admit that the mural quadrant and the mural circle have at each period given the polar distance of Arcturus correct, or at least subject to the same constant error; and as this star has been observed at each period, at all times of the day, and at all seasons of the year, the observations may be considered as perfectly exempt from accidental error. It will I believe be readily conceded that both instruments are so far perfect, that if the error be either nothing, or a given quantity at one point of the arc, the errors must be very nearly indeed the same within a moderate distance, as within 15 degrees, for instance, of that point. Upon this supposition, how can we possibly reconcile the great errors that must

* This has been confirmed by subsequent observation.

have been committed in stars, adjacent as to polar distance, but of opposite right ascensions? I do not wish to press these remarks, in order to obtain greater confidence than they deserve, for observations which can never be regarded with too much suspicion; but the arguments I have used, appear to me to follow logically from the data before us, and strongly to indicate the probability that some cause purely astronomical has, at least, some share in producing these unexpected deviations.

3. The third group, α Herculis, α Pegasi, and Regulus is still more remarkable, being comprehended within two degrees of declination, and two of the stars, α Herculis and α Pegasi* being within half a degree of each other. In this group α Pegasi is at least $3''$ south of its predicted place, whereas the other two stars have not deviated much more than $0''.5$ to the south.

4. α Orionis, α Serpentis, and Procyon, furnish an example equally striking, they being within less than 2° of declination from each other; α Serpentis is exactly in its predicted place, while α Orionis and Procyon are each of them at least $2''$ to the south.

5. Rigel, Spica Virginis, and Sirius, are not contained within so short an arc as the former groups, nor are their places so well determined, on account of their proximity to the horizon; but they afford another instance of the inequality of southern deviation, in stars having nearly the same polar distance, but opposite right ascensions.

But leaving the considerations suggested by these groups of stars, let us examine more minutely the different hypotheses that may be formed on the supposition, that the whole

* The lunar nutation of α Pegasi was nearly a minimum at each period.

of these deviations depends on error of observation caused by some defect in the instruments employed : this investigation becomes the more necessary, as it does not appear that Dr. BRINKLEY, with his instrument at Dublin, has met with similar discordances. Admitting the accuracy of the observations of BRADLEY to form the ground-work of this enquiry, there are then two distinct hypotheses, that may be formed by those, who are inclined to maintain, that the proper motions of the stars are uniform ; and that the discordances in question have their source, not in any astronomical cause, but in some erroneous system of observation. Of the observations from which the catalogues of 1813 and of the present year have been computed, we may suppose the one or the other to be erroneous. Let us consider the consequences of each hypothesis.

Let us first suppose the error to be in the observations of 1813. Then the observations of 1756 and 1822 being supposed perfect, a catalogue for the year 1813 may be computed by interpolation ; such a catalogue is annexed, and this, (assumed to be correct,) compared with the observed catalogue of 1813, will show the errors of observations at that period. On this assumption the Greenwich circle must, in 1813, have been in a very defective state ; and admitting the instrument to be now perfect, this can be only attributed to the insufficiency of the braces which then connected the telescope to the circle ; for this is the only difference between the instrument in its former and in its present state. The natural tendency of any such defect would be, I think, continually to increase, and to give results every year more and more distant from the truth : but this is contrary to the known history of the Greenwich observations, which I

have found gradually for some time past approaching to those results which are obtained at the present day, and which, according to our present hypothesis are supposed to be nearly perfect. If the catalogue of 1813 were really so erroneous, as our present hypothesis would compel us to regard it, then it would appear that Dr. BRINKLEY's catalogue for the same period must have been still more erroneous, as may be seen by inspection of the annexed tables. Now admitting for a moment that there were at that time certain imperfections in the Greenwich and Dublin instruments, no person will believe them to have been so imperfect as our present hypothesis would tend to represent them.

Let us now examine the second hypothesis, which presumes the catalogue of 1813 to have been perfect, and consider what confidence is due to the Greenwich observations of the present day. This investigation is to be regarded as important, not merely with a view to the discussion of the nature of the discordances in question, but also from the circumstance, that instruments of well-known celebrity are represented as giving very different results; for which reason I shall be excused for entering into considerable details on this particular question. As the principal reliance I place on the accuracy of the present catalogue, and on the superiority of the Greenwich circle over all other instruments, with the history of which I am acquainted, is derived from the coincidence of the results obtained by the two independent methods; the one of direct measurement of polar distance, the other of observing the angular distance of the direct and reflected image of the stars, it becomes of some importance to consider in what way this coincidence is a proof of the accuracy of either. The source

of error the most to be dreaded in every instrument whatever, quadrant or circle, is that which will be caused by the flexure of the materials of which the instrument is made. It is impossible in theory that any instrument can be wholly free from this defect. In the Greenwich circle the number of microscopes placed round its circumference have an obvious tendency to diminish this error, though they cannot annihilate it; but they have no tendency whatever to diminish the error arising from the flexure of the telescope attached to the circle.

The effect of flexure in any circle will be, in the first instance, to give an erroneous distance from the pole to the zenith: in instruments that turn in azimuth, of the usual construction, the error thus occasioned will be applied to every star under the form of co-latitude, and a star south of the zenith, will be moreover affected by the probably opposite flexure due to that point of the instrument on which the star is observed. This in stars near the equator, or a little to the northward of it, will in our latitude give an error in polar distance, amounting to about double the error committed in determining the co-latitude. On the contrary, the polar distances of stars north of the zenith, being affected only by the difference of two flexures, will be more accurately determined as they approach nearer to the pole, where the errors will wholly vanish. Now, though in the usual mode of employing the Greenwich circle, viz. in measuring directly polar distance, the co-latitude does not become an object of enquiry, yet any flexure of the circle will produce a system of errors of the same nature as those above pointed out. In instruments, like that of Dublin, which turn in azimuth, and with which the observer has to find the place of all the stars by measur-

ing the double of their zenith distances, if he does not find the same zenith point with different stars (provided the instrument be well divided) he may be sure that flexure takes place; but he cannot infer the converse, that flexure does not take place, from his obtaining with all the stars the same error in the line of collimation. For if the flexure be the same on both sides of the zenith, a supposition by no means improbable, the observer will then have no indication of flexure by the usual method of determining the error of collimation by stars of different altitudes. Let us suppose that, with an instrument liable to flexure, it is required to measure by both methods the meridional distance of any two stars. The angular distance of the direct images will (as we have already seen) be affected by the difference, or by the sum of two flexures, according as the stars are placed on the same, or on opposite sides of the zenith. In viewing the reflected images, the instrument receiving two new positions, will be subject to two new flexures, by the sum or difference of which (as it may happen) the angular distance of the reflected images will be affected.

The most probable supposition to be made concerning the flexures is, that at equal inclinations with the horizon, above and below it, they will be the same nearly both in direction and degree, and therefore that the two images below the horizon will approach by nearly the same quantity that the direct images receded, or vice versa. With an instrument therefore having such a system of flexures, the double altitude of each star will be correctly ascertained; but stars of different altitudes will give different determinations of the horizontal point. From observations thus obtained, a near approxima-

tion to the true angular distance might be inferred, by taking a mean between the distances of the direct and of the reflected images. The least probable supposition concerning the flexures is, that at equal inclinations above and below the horizon, they will be equal, but in opposite directions; the consequence of which would be, that the direct and reflected images would approach to or recede from one another by the same quantity: the double altitudes of each star would be incorrectly given, but every star would give the same determination of the horizontal point. To suppose however the existence of such a system of flexures, would be to suppose that gravity produced the same change of form in the instrument, as if its direction were inverted; and since the horizontal line is that, at which according to the supposed system a contrary flexure will take place, the flexure at or near the horizon should be zero, where, however, according to the known laws of mechanics it ought to be the greatest. Such a system therefore must be considered as mechanically next to impossible.

If then an instrument give the angular distances both by reflection and by direct vision the same, and the same determination of the horizontal line from stars of whatever altitude, there are then only two hypotheses that can be formed respecting such an instrument; either that the flexures are insensible, or that they are such as are absolutely inconsistent with the laws of mechanics. Hence I conclude that the coincidence of the results by direct vision and by reflection, and the uniform determination of the horizontal point, will be the strongest proof of the non-flexure of the instrument, and of the accuracy of both results.*

* I must also notice that the method by reflection possesses, in common with

In illustration of the whole of the preceding observations let us examine two catalogues, those of Dr. BRINKLEY, and Mr. BESSEL, which have lately much excited the attention of astronomers. It is obvious, by merely inspecting these catalogues, a comparison of which with the Greenwich catalogue I here subjoin, that one, or both, of the instruments used by these astronomers must be erroneous; and it seems to me, that the source of error is the very flexure, the nature and effects of which we have been considering. For if we attend to the differences between these two catalogues, we shall find, that the six stars near the equator differ $5''$ from one another, whereas the stars near the zenith do not differ above $2''$. In which direction flexure will effect the zenith distances, is a matter quite accidental, depending on the unequal elevation or depression of the object-end or eye-end of the telescope, in consequence of the unequal strength of the materials. If we suppose error to exist in each of the catalogues, this cause must have had an opposite influence in the two cases: if we compare the Greenwich observations with those of Dr. BRINKLEY, we shall arrive at the same conclusion; namely, that the differences must be caused by flexure in one or both of the instruments; since here also we find that the stars in the neighbourhood of the zenith are affected by only half the difference in polar distance, that is observed in the stars near the equator; and the same conclusions may be drawn from comparing the Greenwich observations with those of Mr. BESSEL. The polar distances of all the stars in Mr. BESSEL's catalogue exceed the instruments turning in azimuth, the advantage of measuring the double of the required angle.

polar distances given in the Greenwich catalogue; while those of all the stars in Dr. BRINKLEY's catalogue as regularly fall short of my determinations. It is not from the casual circumstance of my results being nearly a mean between the results of those two astronomers, that I intend to claim a superior weight of authority for my own; for were this the only ground for preference, I should regard the question as yet undetermined, and should think it my duty to recommend the providing of new and more powerful instruments for ascertaining the truth. But it appears to me that from the observations by reflection, which I have lately made, and from their agreement with my observations by direct vision, that I am entitled to determine the share of error to which each of these two catalogues is liable; not only from the general superiority of the Greenwich circle, which I consider to have been thus proved, but from this peculiar circumstance, that whereas in the two catalogues of Mr. BESSEL and Dr. BRINKLEY, the errors cannot fail to be the greatest in stars near the horizon; by my method of reflection those stars, which are nearest the horizon, must be determined the most correctly, from their double altitudes being measured on the smallest arc.

In stars near the equator the catalogue of Mr. BESSEL differs from that of Dr. BRINKLEY five seconds; and from the preceding considerations, I think we may venture to conclude that Mr. BESSEL's polar distances are too great by about three seconds, and Dr. BRINKLEY's too small by about two: and since my catalogue differs from the two former from the zenith to equator in very nearly the same proportion, there can be no reason to doubt that their errors throughout are divided in nearly the same ratio.

With regard to the catalogue for the present period, which accompanies this paper, I beg to state that I consider it only as a very near approximation to the truth, and requiring at least another year's observations, to render it of equal value with that of 1813, which is the result of two years observations with six microscopes, and in four positions of the telescope.

I am persuaded that the more this subject is considered, the more distinctly it will appear, that if any doubt can be entertained, founded on any circumstance arising out of the Dublin observations, that doubt must relate, not to the accuracy of former catalogues, but to the present position of the stars; since it is with respect to their *present* position that the two instruments are really at variance. This circumstance is very fortunate, as time may confirm the present, or suggest some more satisfactory method of investigation, if what I have now advanced be not thought sufficient for the purpose.

- VII. *On the parallax of α Lyrae.* By JOHN POND, Esq.

Astronomer Royal, F. R. S.

Read November 14, 1822.

My former experiments with a fixed telescope upon α Cygni have always appeared to me so decisive, as to render hopeless any farther attempt to discover its parallax; but respecting that of α Lyrae, my observations with the mural circle were not equally satisfactory; for among the observations of this star we may find occasional discordances that admit of being interpreted in favour of parallax. And although I have been inclined myself to attribute these irregularities to other causes, yet their existence made it desirable to institute new experiments. The method with a fixed telescope, which I had contrived for α Cygni, could not here, I found, be applied successfully; there being no star of nearly the same altitude but opposite in right ascension sufficiently bright to be observed throughout the year, a circumstance quite essential to that mode of observation. I have employed therefore the mural circle to investigate, 1st, the difference of parallax between γ Draconis and α Lyrae: 2dly, the absolute parallax of the latter star; the Dublin observations indicating, it may be remembered, that the parallax of γ Draconis is insensible, but that of α Lyrae a very perceptible quantity. The processes employed in these two investigations being very different, I shall consider each of them separately.

On the difference of parallax between γ Draconis and α Lyra.

It is impossible to conceive a more simple process than that of determining with the mural circle the difference of polar distance between these stars. From their proximity in right ascension, the operation is the same as that of measuring the angular distance of two terrestrial objects, about 12° asunder, with a theodolite surrounded by six microscopes: for the mural circle, in principle, exactly resembles a vertical theodolite; with this difference, that its microscopes, instead of being placed on a frame-work of brass, are securely fixed on a stone pier. Now I find that the angular distance thus measured in winter does not differ one-tenth of a second from the same angular distance measured in summer; and therefore, that the difference of parallax between the two stars is absolutely a quantity too small to be measured. In this investigation, it is to be considered that any constant error in the determination of the absolute polar distances has nothing to do with the question, it being the difference only of those distances at opposite seasons that is required. To render all errors throughout the whole course of observation as constant as possible, the telescope remained fixed to the same part of the limb of the instrument, and the utmost pains were taken to reduce the temperature in the Observatory to that of the outer air; the difference throughout the year not exceeding one degree. The winter of 1821-1822 was extremely favourable for astronomical observation; there were an unusual number of fine nights, and the weather was so mild and uniform, that we were enabled to equalize the temperature, so as to make it of no importance whether the observations were

computed by the outer or inner thermometer; and it is to this circumstance, in a great measure, that I attribute the perfect coincidence between the observations at different seasons.

It has been objected, however, that perhaps some unexpected effect of temperature deranges the instrument by the exact quantity of the difference of parallax attributed to these stars by Dr. BRINKLEY; if we suppose a derangement from temperature so considerable as to give a sensible error, even after being diminished by the effect of six microscopes, we should expect the error to be much greater when the experiment is tried with two microscopes only; for to suppose the contrary, would be to deny the tendency of six microscopes to correct the errors of two. Now I find the same difference of polar distance whether I employ two microscopes or six; temperature, therefore, cannot materially have vitiated the results by causing derangement in the form of the instrument.

In the whole of the above process I do not see one objectionable point, and if called upon to invent an instrument for this particular experiment, I could not devise one more perfect in principle than the mural circle.

Whoever will compare the above simple process with the more complicated one necessarily employed in using an instrument with two microscopes, turning freely in azimuth, will not hesitate, I think, in deciding upon which of the two instruments temperature is likely to produce the greatest error.

On the absolute parallax of α Lyra.

The preceding observations only indicate that γ Draconis

and α Lyrae have the same parallax, or that their difference of parallax is zero; but they have no tendency to show what is the actual magnitude of the parallax that the two stars have in common. If indeed we admit it to be proved, by the observations of BRADLEY, and the more recent ones of Dr. BRINKLEY, that the parallax of γ Draconis is insensible, we may then infer from the observed difference what is the parallax of the other star. But the method of investigation that we are now about to consider, does not depend on such an admission.

Having successfully adopted the method of observing by reflection, I was desirous of employing it in a series of observations upon α Lyrae, with a view to determine this question. This series began on the 1st of July, 1822, and has been continued to the present time.* Although this period embraces only half the interval in which the greatest change or double parallax is affected, a circumstance which at first may appear very disadvantageous, yet that is more than compensated, in my opinion, by the number of observations, and by a uniformity of temperature, such as never can be expected in the extreme seasons of winter and summer.

In observations of this nature the effects of temperature upon the instrument itself, and the uncertain refractions of the ray of light when brought into the lower part of the room, may produce errors of no inconsiderable magnitude, with reference to a question of so much nicety as the present.

I can show however in the present as in the former process, that no error from temperature, affecting the instrument, has

* Since the date of this paper, the observations have been continued throughout the winter, and the results will be found in the subjoined Table.

introduced itself into this series of observations; for I obtain the same result from the readings with two microscopes as from those made with six.

In the case of two microscopes, the angular distance is measured upon two arcs only. Now it cannot be for a moment contended that an error from temperature, so great as not to be corrected by six microscopes, will not be much exaggerated by employing only two. The errors then, if any, must arise from the effects of temperature on refraction, and not from the changes it occasions in the instrument. But from the season which I have chosen for this investigation, and from the care that has been taken to equalize the temperature, the errors arising from the latter cause must be almost insensible. My observations, thus conducted, indicate in the most decided manner, that the parallax of α Lyrae cannot exceed a very small fraction of a second. The advantages and disadvantages of the Dublin and Greenwich methods are in this process much more nearly balanced than in the former. The Dublin instrument has the great advantage of determining the zenith distance in the course of a few minutes, whereas at Greenwich twenty-four hours at least, and frequently several days elapse, before a complete observation of the double altitude can be obtained by the method of reflection. This disadvantage attending the Greenwich method could only be remedied by employing two mural circles for observing a star on the same night, both by direct vision and by reflection.

I have now to consider that argument on which the greatest reliance in favour of parallax has been placed, namely, that founded on the actual determination of the solar equation from the observations made with the Dublin instrument.

This argument may, I think, be thus stated. By a series

of observations made with a given instrument two equations have been disengaged, previously considered as unknown in amount, but known only as to the law of their variation. Of these one is much smaller than the other. Hence it is inferred, that as the instrument has faithfully disengaged the smaller equation (respecting which there is no dispute), it must be admitted with equal fidelity to have disengaged the larger, which might be supposed the easier operation of the two. This reasoning is strictly logical, as proving the disengagement of two equations, but it by no means proves the larger equation to be caused by parallax. The larger equation here to be disengaged is after all so small, that it is impossible, in different points of its period, to show that the law assumed coincides with observation; it is only a rude agreement at the points of the greatest and least variation that can be demonstrated. The disengagement of the larger equation only proves therefore the existence of some regularly recurring cause, acting with greatest effect at the extreme seasons.

The reason, I conceive, why Dr. BRINKLEY does not find parallax in γ Draconis is, that with respect to the zenith point, his instrument, like every one of a similar construction, is a perfect instrument. No portion of the arc is employed, nor can temperature here occasion any errors by its changes. As the star to be examined recedes from the zenith, the instrument becomes less and less perfect; and he finds a small parallax in α Cygni, a larger in α Lyrae, and oftentimes a still larger in stars more remote from the zenith. An additional reason for suspecting that the discordances observed arise from temperature is this: the greatest supposed parallax is found in those stars whose maximum and minimum of parallax would fall in the ex-

treme seasons, and it is not at all improbable that irregular refraction, arising from the unequal state of the temperature within and without the Observatory, may have had a considerable share in occasioning the Dublin discordances, combined, perhaps, with the effect of the changes of temperature upon the instrument itself. It is a circumstance not hitherto sufficiently noticed by astronomers, that there are many cases where the smallest disturbing cause will produce an error quadruple of its own amount; and consequently, that the greatest error to which we are liable from such a cause at any one observation will be only one-fourth of the difference that we can detect between the most discordant of them. Of such a nature are those disturbances which, like refraction for instance, introduce errors, both positive and negative, into the determination of either extremity of the arc that measures the distance between two stars.

By a singular combination of circumstances, not probable certainly when considered *a priori*, but by no means impossible, the variation caused by change of temperature may follow an annual law so little differing from that of parallax, as to bring out the assumed parallax, and to leave the solar nutation disengaged.

Notwithstanding the importance of these investigations to the history of astronomy, and to our forming a correct notion of the system of the universe, yet our decision ultimately turns upon so very small a quantity, that our having reduced the enquiry to these narrow limits, rather tends to show the perfection of each instrument than the defect of either.

On former occasions I considered the question of parallax in the particular case of α Lyrae as undecided, and as perfectly open to future investigation; but the observations of the present year

have produced, on my mind, a conviction approaching to moral certainty. The history of annual parallax appears to me to be this: in proportion as instruments have been imperfect in their construction, they have misled observers into the belief of the existence of sensible parallax. This has happened in Italy to astronomers of the very first reputation. The Dublin instrument is superior to any of a similar construction on the Continent; and accordingly, it shows a much less parallax than the Italian astronomers imagined they had detected. Conceiving that I have established, beyond a doubt, that the Greenwich instrument approaches still nearer to perfection, I can come to no other conclusion than that this is the reason why it discovers no parallax at all.

TABLE I.

	Names of Stars.	Predicted N. P. D. 1823.	Observed N. P. D. 1823.	Diff. South.
		<i>o</i> <i>l</i> <i>u</i>	<i>o</i> <i>l</i> <i>u</i>	<i>u</i>
1	Polaris			
2	β Urs. Min.	15 7 16,38	15 7 15,7	-0,7
3	β Cephei	20 12 53,78	20 12 54,1	+0,3
4	α Urs. Maj.	27 17 44,16	27 17 43,6	-0,6
5	α Cephei	28 9 42,20	28 9 42,8	+0,6
6	α Cassiop.	34 26 4,23	34 26 5,8	+1,6
7	γ Urs. Maj.	35 19 15,18	35 19 14,8	-0,4
8	γ Draconis	38 29 10,31	38 29 10,5	+0,2
9	γ Urs. Maj.	39 47 59,55	39 47 59,6	-0,1
10	α Persei	40 46 38,34	40 46 39,0	+0,7
11	Capella	44 11 35,11	44 11 36,9	+1,8
12	α Cygni	45 20 50,80	45 20 52,4	+1,6
13	α Lyrae	51 22 30,37	51 22 31,2	+0,9
14	Castor	57 43 58,08	57 43 59,1	+1,0
15	Pollux	61 33 16,76	61 33 17,0	+0,3
16	β Tauri	61 33 5,74	61 33 6,7	+1,0
17	α Androm.	61 53 10,75	61 53 12,4	+1,7
18	α Cor. Bor.	62 41 0,07	62 41 0,6	+0,5
19	α Arietis	67 22 42,60	67 22 44,4	+1,8
20	Arcturus	69 53 28,83	69 53 29,2	+0,4
21	Aldebaran	73 51 16,17	73 51 17,7	+1,5
22	β Leonis	74 26 17,73	74 26 18,1	+0,4
23	α Herculis	75 23 59,70	75 24 0,0	+0,3
24	α Pegasi	75 44 38,52	75 44 41,7	+3,2
25	Regulus	77 10 15,00	77 10 15,4	+0,4
26	α Ophiuchi	77 18 9,74	77 18 10,6	+0,9
27	α Aquilæ	81 35 28,31	81 35 29,4	+1,1
28	α Orionis	82 38 2,11	82 38 4,2	+2,1
29	α Serpentis	84 0 36,52	84 0 36,6	+0,1
30	Procyon	84 19 40,75	84 19 43,2	+2,5
31	α Ceti	86 36 34,86	86 36 36,9	+2,1
32	α Aquarii	91 10 28,85	91 10 31,3	+2,5
33	α Hydræ	97 53 43,20	97 53 44,5	+1,3
34	Rigel	98 24 46,44	98 24 48,5	+2,0
35	Spica Virg.	100 14 0,73	100 14 0,7	0,0
36	Sirius	106 28 45,35	106 28 48,9	+3,5
37	Antares	116 1 42,50	116 1 44,1	+1,6

TABLE II.

	Names of Stars.	Predicted N. P. D. 1823.	Observed N. P. D. 1823.	Diff. South.
1	α Cassiopeie	34 26 4.23	34 26 5.8	+1.6
2	Polaris			
3	α Arietis	67 22 42.60	67 22 44.4	+1.8
4	α Ceti	86 36 34.86	86 36 36.9	+2.0
5	α Persei	40 46 38.34	40 46 39.0	+0.7
6	α Aldebaran	73 51 16.17	73 51 17.7	+1.5
7	Capella	44 11 35.11	44 11 36.9	+1.8
8	Rigel	98 24 46.44	98 24 48.5	+2.0
9	β Tauri	61 33 5.74	61 33 6.5	+0.8
10	α Orionis	82 38 2.11	82 38 4.2	+2.1
11	Sirius	106 28 45.35	106 28 48.9	+3.5
12	Castor	57 43 58.08	57 43 59.1	+1.0
13	Procyon	84 19 40.75	84 19 43.2	+2.5
14	Pollux	61 33 16.76	61 33 17.0	+0.2
15	α Hydræ	97 53 43.20	97 53 44.5	+1.3
16	Regulus	77 10 15.00	77 10 15.6	+0.6
17	α Urs. Maj.	27 47 44.16	27 47 43.4	-0.6
18	β Leonis	74 26 17.73	74 26 18.1	+0.4
19	γ Urs. Maj.	35 19 15.18	35 19 14.4	-0.4
20	Spica Virg.	100 14 0.73	100 14 0.7	0.0
21	α Urs. Maj.	39 47 59.60	39 47 59.5	-0.1
22	Arcturus	69 53 28.83	69 53 29.2	+0.4
23	β Urs. Min.	15 7 16.38	15 7 15.6	-0.8
24	α Cor. Bor.	62 41 0.07	62 41 0.6	+0.5
25	α Serpentis	84 0 36.52	84 0 36.6	+0.1
26	Antares	116 1 42.50	116 1 44.1	+1.6
27	α Herculis	75 23 59.70	75 24 0.0	+0.3
28	α Ophiuchi	77 18 9.74	77 18 10.6	+0.9
29	γ Draconis	38 29 10.31	38 29 10.5	+0.2
30	α Lyræ	51 22 30.37	51 22 30.2	-0.9
31	α Aquilæ	81 35 28.31	81 35 29.4	+1.1
32	α Cygni	45 20 50.80	45 20 52.4	+1.6
33	α Cephei	28 9 42.20	28 9 42.9	+0.7
34	β Cephei	20 12 53.78	20 12 54.1	+0.3
35	α Aquarii	91 10 28.85	91 10 31.3	+2.5
36	α Pegasi	75 44 38.52	75 44 41.7	+3.2
37	α Androm.	61 53 10.75	61 53 12.2	+1.7

TABLE III.

Names of Stars.	Interpolated N. P. D. 1813. from 1756 & 1823.	Difference.	
		Dublin.	Greenwich.
1 Polaris	0 1 11	"	"
2 β Ursæ Min.	15 4 48.2	- 1.1	- 0.8
3 α Cephei	20 15 31.0	+ 0.1	+ 0.4
4 α Ursæ Maj.	27 14 31.0	+ 0.7	- 0.6
5 α Cephei	28 12 13.6	+ 0.3	+ 1.0
6 α Cassiop.	34 29 24.1	+ 2.2	+ 1.3
7 γ Ursæ Maj.	35 15 54.8	- 0.7	- 0.5
8 γ Draconis	38 29 3.7	+ 0.7	+ 0.1
9 γ Ursæ Maj.	39 44 58.1	+ 0.5	+ 0.2
10 α Persei	40 48 53.2	+ 2.6	+ 0.7
11 Capella	44 12 12.0	+ 2.1	+ 1.5
12 α Cygni	45 22 58.4	+ 0.9	+ 1.3
13 α Lyrae	51 23 1.2	+ 1.3	+ 0.6
14 Castor	57 42 47.9	+ 1.3	+ 1.1
15 Pollux	61 31 57.1	+ 2.0	+ 0.6
16 β Tauri	61 33 44.8	+ 1.6	+ 1.0
17 α Androm.	61 56 31.6	+ 2.3	+ 1.3
18 α Cor. Bor.	62 38 55.9	+ 1.5	+ 0.4
19 α Arietis	67 25 38.4	+ 2.7	+ 1.8
20 Arcturus	69 50 19.3	+ 1.1	+ 0.2
21 Aldebaran	73 52 36.7	+ 1.9	+ 1.4
22 β Leonis	74 22 57.5	+ 2.3	+ 0.2
23 α Herculis	75 23 14.3	+ 1.1	+ 0.3
24 α Pegasi	75 47 54.2	+ 2.5	+ 2.5
25 Regulus	77 7 23.0	+ 1.2	+ 0.3
26 α Ophiuchi	77 17 39.6	+ 0.4	+ 0.6
27 α Aquilæ	81 36 59.7	+ 1.2	+ 0.8
28 α Orionis	82 38 17.4	+ 2.8	+ 1.7
29 α Serpentis	82 58 39.4	+ 2.0	+ 0.1
30 Procyon	84 18 16.7	+ 2.8	+ 2.3
31 α Ceti	86 39 2.5	+ 1.9	+ 1.7
32 α Aquarii	91 13 24.0	+ 3.8	+ 2.4
33 α Hydrae	97 51 12.4	+ 3.0	+ 1.1
34 Rigel	98 25 35.5	+ 2.8	+ 1.7
35 Spica Virg.	100 10 51.3	+ 1.7	+ 0.5
36 Sirius.	106 28 4.2	+ 1.9	+ 2.7

TABLE IV.

Names of Stars.	N. P. D. 1822. I.	No. of Obs.	N. P. D. 1822. II.	No. of Obs.	N. P. D. 1822. III.	No. of Obs.	N. P. D. 1822. IV.	No. of Obs.
1 Polaris	0 1 38 27.0	300	0 1 38 27.0	300	0 1 38 27.0	300	0 1 38 27.0	300
2 β Ursæ Min.	15 7 0.8	91	15 7 1.0	22 18	15 7 0.5	22 18	15 7 0.4	92
3 β Cephei	20 13 9.7	44	9.7	21 18	9.8	21 18	9.2	46
4 α Ursæ Maj.	27 17 24.6	53	24.4	14 13	23.9	12 10	24.1	53
5 α Cephei	28 9 57.5	37	57.9	25 20	58.1	25 20	57.7	41
6 α Cassiopeizæ	34 26 25.6	51	26.0	12 8	25.9	12 8	25.3	56
7 γ Ursæ Maj.	35 18 54.8	45					55.0	45
8 γ Draconis	38 29 9.8	120					9.7	120
9 α Ursæ Maj.	39 47 41.5	95					40.7	95
10 α Persei	40 46 52.5	48					53.1	51
11 Capella	44 11 41.4	75	41.4	25 20	41.5	25 20	41.6	75
12 α Cygni	45 21 5.0	80	5.1	40 40	5.4	40 40	5.1	84
13 α Lyrae	51 22 34.5	87	34.0	60 60	34.2	60 60	34.8	89
14 Castor	57 43 52.2	60	52.0	20 18	52.3	20 18	52.2	52
15 Pollux	61 33 9.1	60	8.8	15 15	8.8	15 15	8 9	50
16 β Tauri	61 33 10.5	50	10.3	16 16	10.5	16 16	10.2	46
17 α Androm.	61 53 32.6	30	32.0	12 10	32.4	12 10	32.4	37
18 α Cor. Bor.	62 40 48.3	26	48.1	16 16	48.1	22 18	48.3	32
19 α Arietis	67 23 1.6	44	1.8	24 17	2.0	24 17	1.6	49
20 Arcturus	69 53 10.2	84	10.2	21 22	10.5	21 22	10.0	84
21 Aldebaran	73 51 25.6	58	25.5	20 16	25.6	20 16	25.4	66
22 β Leonis	74 25 58.5	16	58.1	16 16	58.3	16 16	58.7	16
23 α Herculis	75 23 55.5	17	55.6	10 13	56.3	21 24	55.7	31
24 α Pegasi	75 45 1.0	30	1.1	24 20	1.4	24 20	1.4	34
25 Regulus	77 9 57.8	54	58.5	33 25	59.1	33 22	58.7	54
26 α Ophiuchi	77 18 7.6	20	7.8	10 12	7.6	21 25	7.3	34
27 α Aquilæ	81 35 38.7	70	38.6	44 42	38.9	44 42	39.0	86
28 α Orionis	82 38 5.7	48	5.6	12 12	6.1	14 14	5.7	54
29 α Serpentis	83 0 25.3	31	24.7	17 14	25.4	17 14	25.5	37
30 Procyon	84 19 34.8	57	34.6	10 7	34.9	10 7	34.5	63
31 α Ceti	86 36 51.4	46					51.2	46
32 α Aquarii	91 10 48.6	40	48.7	26 15	48.9	27 15	49.0	40
33 α Hydræ	97 53 29.2	18	29.4	16 12	29.4	16 12	30.0	18
34 Rigel	98 24 53.3	11					53.8	19
35 Spica Virg.	100 13 41.6	22	41.8	22 24	41.2	22 24	41.6	21
36 Sirius	106 28 44.4	75	44.3	7 7	43.9	7 7	44.5	75
37 Antares.	116 1 35.5	5	35.4	5 5	35.6	5 5	36.0	5

No. I, is computed in the usual manner by direct measurement from the Pole.

No. II, by the angular distance of the stars from their reflected images in an artificial horizon, co-latitude assumed $38^{\circ} 31' 21''$.

No. III, computed in the same manner as No. II, but from observations with two microscopes only.

No. IV, computed from observations with two microscopes in the same manner as No. I.

TABLE V.

	Error of Catalogue I.	Error of Catalogue II.	Error of Catalogue III.	Error of Catalogue IV.	
1 Polaris	"	"	"	"	
2 β Ursæ Min.	0,0	+0,2	-0,3	-0,4	
3 β Cephei	0,0	0,0	+0,1	-0,5	
4 α Ursæ Maj.	+0,2	-0,1	0,5	-0,3	
5 α Cephei	-0,3	+0,1	+0,3	-0,1	
6 α Cassiop.					This star was found to be too near the zenith to be observed accu- rately by reflection.
7 γ Ursæ Maj.					
8 γ Draconis					
9 α Ursæ Maj.					
10 α Persei					
11 Capella	+0,1	0,0	+0,1	+0,3	
12 α Cygni	-0,1	0,0	+0,3	0,0	
13 α Lyrae	+0,3	-0,2	0,0	+0,6	Discordant from error of division.
14 α Castor	0,0	+0,1	+0,1	0,0	
15 Pollux	+0,1	-0,2	0,2	-0,1	
16 β Tauri	+0,1	-0,1	+0,2	-0,2	
17 α Androm.	+0,1	+0,1	-0,1	-0,1	
18 α Cor. Bor.	+0,1	-0,1	-0,1	+0,1	
19 α Arietis	-0,1	+0,1	+0,3	-0,1	
20 Arcturus	0,0	0,0	+0,3	-0,2	
21 Aldebaran	0,0	0,0	+0,0	-0,2	
22 β Leonis	+0,2	-0,2	+0,0	+0,4	
23 α Herculis	-0,1	0,0	+0,7	+0,1	No. III. discordant from the observ- having been made at different seasons.
24 α Pegasi	0,0	0,0	+0,2	+0,2	
25 Regulus	-0,4	+0,3	+0,4	+0,5	This star is reserved for future ex- amination.
26 α Ophiuchi	+0,2	0,0	+0,5	+0,1	
27 α Aquilæ	0,0	0,0	+0,2	+0,3	
28 α Orionis	+0,1	+0,0	+0,4	0,0	
29 α Serpentis	+0,3	-0,3	+0,4	+0,5	Discordant from the different sea- sons of observation, and requiring examination.
30 Procyon	+0,2	0,0	+0,3	-0,1	
31 α Ceti	-0,1	0,0	+0,3	+0,4	
32 α Aquarii	-0,1	-0,0	0,0	+0,6	
33 α Hydræ					
34 Rigel					
35 Spica Virg.	-0,2	0,0	-0,6	-0,2	
36 Sirius.	+0,1	0,0	-0,4	+0,2	
37 Antares.	0,0	0,0	+0,1	+0,5	
Sum of Errors	3,8	2,3	8,0	7,3	
Mean Error	0,13	0,08	0,26	0,25	

From the exact coincidence of Catalogue I. and II. it may be inferred that the assumed co-lat. $36^{\circ} 31' 21''$ is extremely near the truth.

MDCCXXXIII,

K

TABLE VI.

		N. P. D. 1822. Greenwich.	N. P. D. 1822. Dublin.	Difference in 1822.		Difference in 1812.		Difference between Greenwich and Dublin.
1	Polaris	0 38 26.9	26.7	-0.2				
2	♂ Ursæ Min.	15 7 0.8	1.8	+1.0				
3	♂ Cephei	20 13 9.8	9.8	0.0				
4	♂ Ursæ Maj.	27 17 24.3	24.1	-0.2	} -0.6	} -1.9	} -0.3	
5	♂ Cephei	28 9 58.0	57.3	-0.8				
6	♂ Cassiop.	34 26 25.8	23.3	-2.5				
7	γ Ursæ Maj.	35 18 54.4	54.5	+0.1				
8	γ Draconis	38 29 9.8	8.9	+1.0	} -1.3	} -0.6	} -0.7	} +1.5
9	♂ Ursæ Maj.	39 47 41.6	41.0	-0.6				
10	♂ Persei	40 46 52.5						
11	Capella	44 21 41.4	39.8	-1.6				
12	♂ Cygni	45 21 5.0	3.7	-1.3	} -1.9	} -0.5	} -0.8	} +2.4
13	♂ Lyre	51 22 54.2	32.9	-1.3				
14	Castor	57 43 52.0	50.7	-1.3				
15	Pollux	61 33 9.0	8.2	-0.8				
16	♂ Tauri	61 33 10.4	9.4	-1.0	} -1.9	} -0.5	} -0.8	} +2.4
17	♂ Androm.	61 53 32.5	30.9	-1.6				
18	♂ Cor. Bor.	62 40 48.2	46.8	-1.4				
19	♂ Arietis	67 23 1.7	0.2	-1.5				
20	Arcturus	69 53 10.2	9.5	-0.7	} -1.9	} -0.7	} -0.8	} +2.4
21	Aldebaran	73 51 25.6	24.2	-1.4				
22	♂ Leonis	74 25 58.1	56.6	-1.5				
23	♂ Herculis	75 23 55.5						
24	♂ Pegasi	75 45 1.0			} -1.9	} -0.5	} -0.8	} +2.4
25	Regulus	77 9 58.2	58.1	-0.1				
26	♂ Ophiuchi	77 18 7.4	6.2	-1.2				
27	♂ Aquilæ	81 35 38.5	36.6	-1.9				
28	♂ Orionis	82 38 5.6	4.0	-1.6	} -1.9	} -0.5	} -0.8	} +2.4
29	♂ Serpentis	83 0 24.9	23.5	-1.4				
30	Procyon	84 19 34.8	32.9	-1.7				
31	♂ Ceti	86 36 51.4	49.5	-1.9				
32	♂ Aquarii	91 10 48.0	45.7	-2.3	} -1.9	} -0.5	} -0.8	} +2.4
33	♂ Hydre	97 53 29.3						
34	Rigel	98 24 53.2						
35	Spica Virg.	100 13 41.8	40.9	-0.9				
36	Sirius.	106 28 44.3	42.3	-2.0				

6. ♂ Cassiop. I suspect some mistake in the computations of this star; I have therefore in taking the mean, substituted ♂ Persei for it, which Dr. BRINKLEY was so obliging as to send me a few days since.

25. Regulus. There is probably also some mistake relative to this star.

36. Sirius. By a number of observations made last year at the same period, and computed by the same equations: the two results differ exactly 2". This seems therefore to be the quantity by which the two instruments differ in measuring an angle of 100°.

TABLE VII.

		Bradley's refract. N. R. D. 1820. Dr. Brinkley.	N. P. D 1820. Mr. Bessel.	Difference between Dr. Brinkley and Mr. Bessel.
1	Polaris	0 39 5, 6		
2	β Ursæ Min.	15 6 32, 2		
3	β Cephei	20 13 41, 0		
4	α Ursæ Maj.	27 10 45, 8		
5	α Cephei	28 10 27, 3		
6	α Cassiopeiae	34 27 3, 0		
7	γ Ursæ Maj.	35 18 14, 5		
8	γ Draconis	38 29 7, 5		
9	γ Ursæ maj.	39 47 4, 8		
10	α Persei		0	
11	α Capella	44 11 48, 8	50,88	2,1
12	α Cygni	45 21 28, 9	31,53	2,6
13	α Lyræ	51 22 39, 0	42,23	3,2
14	α Castor	57 43 36, 3	38,95	2,6
15	α Pollux	61 32 52, 0	54,46	2,5
16	β Tauri	61 33 16, 9	19,60	2,7
17	α Androm.	61 54 10, 7	13,41	2,7
18	α Cor Bor.	62 40 21, 9	25,51	3,7
19	α Arietis	67 23 34, 7	37,68	3,0
20	α Arcturus	69 52 31, 5	34,57	3,0
21	α Aldebaran	73 51 40, 1	42,84	2,7
22	β Leonis	74 25 16, 5	19,96	3,5
23	α Herculis			
24	α Pegasi			
25	α Regulus	77 9 23, 5	26,42	2,9
26	α Ophiuchi	77 18 0, 0	4,34	4,3
27	α Aquilæ	81 35 54, 7	59,31	4,6
28	α Orionis	82 36 0, 5	9,34	2,8
29	α Serpentis	83 0 0, 0	5,16	5,2
30	α Procyon	84 19 15, 5	19,68	4,2
31	α Ceti	86 37 18, 3	22,33	5,0
32	α Aquarii	91 11 20, 5	25,48	5,0
33	α Hydræ		97 53 1,68	
34	α Rigel			
35	α Spica Virg.	100 13 4, 4	7,69	3,3
36	α Sirius	106 28 33, 1	37,15	4,0
37	α Antares.			
	γ Aquilæ.	79 49 1, 6	6,03	4,4
	β	84 2 3, 3	9,16	5,9
	1 } α Capri.	103 3 19,60	25,59	6,0
	2 }	103 5 37,03	43,49	6,5
	γ Pegasi.	75 48 59, 3	49 3,78	4,5

TABLE VIII.
General Catalogue of Stars for the year 1819.

1750 & 1819. An. Var. 1818.	Number.	Names of Stars.	R. 1825.	Predicted N. P. D. 1825.	Observed N. P. D. 1825. Bradley's Refrac- tion.	Stars observed South.	No. of Observations.			Interpolated Cata- logue N. P. D. 1818. 1813 + 1823. 2.	No. of Observations.	
							1756.	1812. 1813.	1822. 1823.			
— 20,09	1	γ Pegasi	h. m. s.	0 4 8,09	75 48 0,11	75 48 2,4	2,3	14	25	13	76 49 41,7	38
— 19,85	2	α Cassiopeiz	0 30 31,29	34 26 4,23	34 26 5,7	1,5	5	77	19	34 27 44,5	136	
	3	Polaris *	0 57 46,4		1 38 7,5			200	300	1 39 44,5	500	
— 17,40	4	α Arietis	1 57 13,09	67 22 42,60	67 22 44,4	1,8	10	77	91	67 24 10,6	168	
— 14,59	5	α Ceti	2 53 2,29	46 36 34,86	46 36 36,8	2,0	7	18	31	46 37 48,7	49	
— 13,41	6	α Persei	3 11 44,48	40 46 38,34	40 46 39,0	0,7	10	66	48	40 47 45,7	114	
— 7,92	7	Aldebaran	4 25 46,58	73 51 16,17	73 51 17,7	1,5	60	69	74	73 51 56,4	143	
— 4,54	8	α Capella	5 3 37,33	44 11 35,11	44 11 36,9	1,8	59	108	95	44 11 58,8	203	
— 4,74	9	α Rigel	5 6 2,21	98 24 46,44	98 24 48,4	2,0	37	30	11	98 25 11,2	41	
— 3,80	10	β Tauri	5 15 6,76	61 33 5,74	61 33 6,7	1,0	14	70	66	61 33 25,0	136	
— 1,36	11	α Orionis	5 45 35,66	82 38 2,11	82 38 4,2	2,1	69	66	62	82 38 9,9	128	
— 4,41	12	α Sirius	6 37 20,85	106 28 45,35	106 28 48,7	3,4	84	30	82	106 28 25,1	112	
— 7,12	13	α Castor	7 23 17,62	57 43 58,08	57 43 59,1	1,0	19	47	78	57 43 53,3	125	
— 8,63	14	α Procyon	7 30 2,19	84 19 40,75	84 19 43,2	2,4	64	40	64	84 18 58,9	104	
— 8,02	15	α Pollux	7 34 28,52	61 33 16,76	61 33 17,1	0,3	38	53	75	61 33 36,8	128	
— 15,19	16	α Hydraz	9 18 53,50	97 53 43,20	97 53 44,5	1,3	5	10	30	97 53 27,9	40	
— 17,23	17	α Regulus	9 58 56,36	77 10 15,00	77 10 15,4	0,4	25	68	79	77 8 49,2	147	
— 19,26	18	α Ursæ Maj.	10 52 43,41	27 17 44,16	27 17 43,6	0,6	7	26	80	27 16 7,6	150	
— 20,04	19	β Ursæ Maj.	11 40 1,66	74 26 17,73	74 26 18,1	0,4	11	23	32	74 24 37,7	54	
— 19,98	20	γ Ursæ Maj.	11 44 28,63	35 19 15,18	35 19 14,8	0,4	5	60	45	35 17 34,9	105	
— 18,94	21	α Spica Virg.	13 15 52,91	100 14 0,73	100 14 0,7	0,0	19	20	40	100 12 26,0	66	
— 18,15	22	α Ursæ Maj.	13 40 33,54	39 47 59,60	39 47 59,5	0,1	Z. Sect.	100	95	39 46 28,9	195	
— 18,97	23	α Arcturus	14 7 35,61	69 53 28,83	69 53 29,2	0,4	106	120	106	69 51 54,1	226	
— 15,30	24	α Libræ	14 40 54,93	105 15 11,91	105 15 12,5	0,6	4	12	14	105 13 56,8	26	
— 15,32	25	α Cor. Bor.	14 41 6,36	105 17 55,62	105 17 56,3	0,6	11	15	30	105 16 39,5	35	
— 14,74	26	β Ursæ Min.	14 51 19,53	15 7 16,38	15 7 15,6	0,8	1	110	109	15 6 2,3	219	
— 12,45	27	α Cor. Bor.	15 27 11,95	62 41 0,07	62 41 0,6	0,5	7	90	42	62 39 58,1	132	
— 11,72	28	α Serpente	15 35 33,53	83 0 36,52	83 0 36,6	0,1	5	77	45	82 59 38,0	122	
— 8,59	29	α Antares	16 18 34,73	106 1 44,50	110 1 44,1	1,6	21	36	10	116 1 0,1	46	
— 4,57	30	α Herculis	17 6 35,00	79 23 59,70	75 24 0,1	0,4	7	35	30	75 23 37,0	85	
— 3,08	31	α Ophiuchi	17 26 43,49	77 18 9,74	77 18 10,6	0,9	3	83	32	77 17 54,7	115	
— 0,67	32	α Draconis	17 52 30,14	38 29 10,31	38 29 10,5	0,2	Z. Sect.	140	120	38 29 7,1	260	
— 3,02	33	α Lyræ	18 30 56,98	51 22 30,37	51 22 31,2	0,8	89	170	147	51 22 45,9	317	
— 8,34	34	γ Aquilæ	19 37 50,82	79 48 35,58								
— 9,06	35	β Aquilæ	19 42 8,94	81 35 28,31	81 35 29,5	1,2	104	140	112	81 36 14,2	252	
— 8,56	36	α Capri.	19 46 37,27	84 1 37,94								
— 10,65	37	β Capri.	20 7 49,91	103 2 48,83	103 2 49,6	1,0	6	35	22	103 3 42,5	57	
— 10,68	38	α Cygni	20 8 13,69	103 5 5,45	103 5 6,6		10	28	22	103 5 59,4	50	
— 12,63	39	β Cygni	20 35 24,19	45 20 50,80	45 20 52,4	1,6	55	120	120	45 21 54,5	240	
— 15,07	40	α Cephei	21 14 21,05	28 9 42,20	28 9 42,8	0,6	5	70	50	28 10 57,7	127	
— 15,68	41	β Cephei	21 26 20,44	20 12 53,78	20 12 54,0	0,2	5	70	62	20 12 12,5	132	
— 17,27	42	α Aquarii	21 56 41,55	91 10 28,85	91 10 31,4	2,5	9	20	55	91 11 56,4	75	
	43	α Fomalhaut	22 47 50,97									
— 19,32	44	α Pegasi	22 55 57,20	75 44 38,52	75 44 41,8	3,3	6	30	50	75 46 16,7	80	
— 19,95	45	α Andromedæ.	23 59 15,61	61 53 10,75	61 53 12,5	1,8	11	40	40	61 54 51,4	80	

* The mean of about 1300 observations of the pole star during the last ten years, is $1^{\circ} 39' 44''.5$ for the N. P. D. for Jan. 1, 1818, and the mean of all the annual variations $19''.42$ or $19''.43$.

TABLE IX.
Observations of α Lyrae.
Two Microscopes.

Summer.				Autumn.				Winter.			
	Direct.		Reflection.		N. P. D.		Reflection.		Direct.		Reflection.
1822.	0' 40"	1822.	0' 40"	1822.	0' 40"	1822.	0' 40"	1822.	0' 40"	1822.	0' 40"
July 3	32.82	July 1	7.94	Aug. 29	34.41	Aug. 31	7.37	Nov. 3	36.05	Oct. 31	9.15
4	34.04	6	8.54	Sept. 3	34.53	Aug. 31	7.37	Nov. 7	35.04	Nov. 7	8.58
10	34.88	14	8.51	4	34.32	Sept. 1	7.19	21	34.53	21	9.74
17	34.92	19	8.59	6	35.13	7	7.59	27	35.08	27	8.70
20	34.38	31	8.45	8	34.35	10	7.12	2	34.54	2	7.69
21	35.28	Aug. 2	7.73	13	34.75	13	7.55	3	36.07	3	8.43
24	34.04	5	8.03	14	33.87	19	9.02	7	36.28	7	8.81
25	34.09	11	8.05	20	34.39	20	7.44	26	35.81	26	9.02
28	35.15	12	8.55	21	34.76	21	10.24	28	33.79	28	10.26
30	34.39	14	9.11	29	35.15	29	8.73	29	34.72	29	9.07
Aug. 4	33.36	16	8.20	30	35.37	Oct. 3	9.00	10	35.09	1823.	7.63
8	34.80	18	9.06	Oct. 5	36.59	4	9.52	11	35.82	Jan. 8	8.83
10	35.82	20	9.81	6	34.79	8	8.30	21	35.60	11	6.94
13	34.79	21	8.07	7	34.86	11	7.03	22	33.90	13	7.22
15	34.40	23	8.26	12	34.49	18	8.84	26	33.84	Feb. 7	8.84
17	33.70	25	8.04	22	34.23	22	7.70	1823.			
19	33.68	31	7.18	23	35.57	25	8.43	Jan. 18	35.83	12	8.57
22	35.88	26		26	34.50	27	9.00	Feb. 3	35.15	18	6.75
27	35.07	28		28	35.31			13	35.08	19	8.71
								25	34.46	25	8.85
								23	35.28	Mar. 1	7.95
Mean of 19 = 34.63 Mean of 17 = 8.45				Mean of 19 = 34.76 Mean of 17 = 8.44				Mean of 20 = 35.16 Mean of 20 = 8.49			
$R-D = 16.91$ of altitude.				$R-D = 16.74$ of altitude.				$R-D = 16.67$ of altitude.			

TABLE X.
Observations of α Lyrae.
Six Microscopes.

Summer.				Autumn.				Winter.			
Direct.	Refraction.	1822.	1823.	Direct.	Refraction.	1822.	1823.	Direct.	Refraction.	1822.	1823.
$46^{\circ} 25'$	$0^{\circ} 40'$	July 3	July 6	$46^{\circ} 25'$	$0^{\circ} 40'$	Aug. 29	Aug. 31	$46^{\circ} 25'$	$0^{\circ} 40'$	Nov. 4	Oct. 31
33.42	8.54	10	14	34.71	8.57	Aug. 29	Aug. 31	34.63	8.55	Nov. 7	Oct. 31
34.84	8.04	17	19	35.13	8.09	Sept. 1	Sept. 1	34.42	8.26	Nov. 21	Nov. 7
34.28	8.11	20	22	35.16	8.20	6	7	34.21	9.54	Dec. 27	Nov. 21
34.32	7.29	26	28	34.81	7.37	8	10	34.46	9.60	Dec. 27	Nov. 21
34.58	7.35	31	31	32.35	7.95	11	13	34.30	8.69	Dec. 27	Nov. 21
34.68	8.13	Aug. 2	Aug. 2	32.35	8.13	14	16	34.35	8.27	Dec. 27	Nov. 21
33.04	8.53	5	5	33.69	8.53	16	18	34.40	8.68	Dec. 27	Nov. 21
33.09	8.35	11	11	34.17	7.44	20	22	34.49	8.67	Dec. 27	Nov. 21
34.45	8.35	18	18	34.86	8.35	23	25	34.59	8.67	Dec. 27	Nov. 21
33.30	9.61	28	28	33.81	9.61	28	30	34.57	8.67	Dec. 27	Nov. 21
33.26	8.39	Oct. 30	Oct. 30	34.47	8.39	30	32	34.50	8.67	Dec. 27	Nov. 21
33.45	8.36	16	16	34.47	8.36	30	32	34.50	8.67	Dec. 27	Nov. 21
33.82	9.21	18	18	35.68	9.21	30	32	34.50	8.67	Dec. 27	Nov. 21
34.70	9.21	20	20	35.68	9.21	30	32	34.50	8.67	Dec. 27	Nov. 21
34.40	8.66	21	21	34.75	8.66	30	32	34.50	8.67	Dec. 27	Nov. 21
33.88	7.64	23	23	35.69	7.64	30	32	34.50	8.67	Dec. 27	Nov. 21
34.98	8.08	25	25	35.12	8.08	30	32	34.50	8.67	Dec. 27	Nov. 21
34.47		26	26	34.30		30	32	34.50	8.67	Dec. 27	Nov. 21
				33.68		30	32	34.50	8.67	Dec. 27	Nov. 21
				33.89		30	32	34.50	8.67	Dec. 27	Nov. 21

Mean of 19 = 34.39	Mean of 17 = 8.41	Mean of 20 = 34.53	Mean of 17 = 8.29
$\frac{R-D}{2} = 17.01$ of altitude.	$\frac{R-D}{2} = 16.88$ of altitude.	$\frac{R-D}{2} = 17.02$ of altitude.	$\frac{R-D}{2} = 17.02$ of altitude.

TABLE XI.

a Lyrae compared with γ Draconis.

		No. of Obs. of γ Draconis	No. of Obs. of <i>a</i> Lyrae				
1813	Summer	30	24	-	-	12 53 56.77	
1813	Summer	36	40	-	-	12 53 56.77	
Mean of 2 years				-	-	12 53 56.77	
1813	Winter	16	23	-	-	12 53 57.02	
1813	Winter	15	30	-	-	12 53 56.80	
Mean of 2 years				-	-	12 53 56.91	
Double Parallax of <i>a</i> Lyrae				-	-	0.14	
1822	Winter	24	30	-	-	12 53 24.7	
1822	Summer	50	25	-	-	12 53 24.7	
1823	Winter	40	27	-	-	12 53 24.7	
Double Parallax of <i>a</i> Lyrae				-	-	0.0	

Explanation of the preceding Tables.

TABLE I. The predicted catalogue in this table is obtained from the Greenwich Catalogues of 1756 and 1813: all the computations will be found at length in the volume of the Greenwich Observations for 1820. The five groupings of stars in the last column are those referred to in page 42.

TABLE II. is the same catalogue arranged in the order of right ascension.

TABLE III. is an interpolated catalogue: it was computed some time since from a catalogue less perfect than the present, but it is sufficiently exact to show that no explanation of the difficulty can be obtained by supposing any defect in the observations of 1813. The numbers in this table under the columns Dublin and

Greenwich, are the quantities that must be applied to the Dublin and Greenwich observations to produce the interpolated catalogue.

TABLE IV. contains four catalogues, in which, as no systematic difference can be traced, the instrument must be considered as perfect within the limits of the small discordances in Catalogue I. and II.

TABLE V. contains the errors of each of the preceding catalogues. From this table it appears, that the regular difference between the results with six and with two microscopes, is now nearly insensible. This must have arisen formerly from flexure; and the new braces, though intended only to strengthen the attachment of the telescope to the circle, have, in fact, added strength and firmness to the whole frame of the instrument. (Vide Experiments on this subject in the volume of Observations for 1820.)

TABLE VI. shows the difference between the results of the Dublin and Greenwich circle, both at the present time, and in the year 1812. From this it is evident that a small change has taken place in one of the instruments. Formerly the two instruments differed only one second in an arc of 90° ; at present, the difference amounts very exactly to double that quantity.

TABLE VII. contains the two catalogues of Dr. BRINKLEY and Mr. BESSEL. Here the differences are much greater and more irregular.

TABLE VIII. contains a general catalogue of the stars, including several that were not very accurately observed in 1813; but which, nevertheless, confirm in a remarkable manner the general law of southern deviation.

TABLES IX, X and XI. contain observations of α Lyræ, by which it appears, that whatever may be the parallax of this star, it is not within the powers of our instrument to detect it. With Dr. BRINKLEY'S Refraction, the result would have been a very small fraction of a second less in favour of parallax.

VIII. *Observations on the heights of places in the Trigonometrical Survey of Great Britain, and upon the Latitude of Arbury Hill.*

By B. BEVAN, Esq. Communicated by Sir H. DAVY, Bart.

P. R. S.

Read May 23, 1822.

THE Trigonometrical Survey of Great Britain having from time to time engaged the attention of the Royal Society, and circumstantial particulars of this great national undertaking having occupied the pages of the Philosophical Transactions, I beg leave to submit a few observations on that subject to the consideration of the Society.

The result of the survey, relative to the different sections of the meridian, in this country, has not altogether proved so satisfactory as might have been expected.

I have lately examined the calculations affected by the observations made at *Arbury Hill* in the county of Northampton, with some hope of discovering the means of reconciling the anomaly in that part of the meridian.

I have been at the expense of having the height of this station determined by accurate levelling to the Grand Junction Canal, from which, and the known difference of level of the various canals connected with this, I have been able to find the *relative* height of this station, with most of the important objects in the counties of Northampton, Buckingham, and Bedford.

From this operation of levelling, I found the country to the north of Arbury station, suddenly to fall about 400 feet, and continue at this depressed state for 9 or 10 miles. Such a defect of matter, to the north of the station, was in itself a

strong ground for supposing a deflection of the plumb-line to the southward. To ascertain if this supposition were supported by the trigonometrical operations, I calculated the latitude of Arbury station, from the latitude of Blenheim, as determined by previous observation, independent of any astronomical observation made at Arbury, and find it *5 seconds LESS* than shown by the zenith sector; giving countenance to the probability of local attraction by the high land to the *south* of the station, which will appear by the following calculation; in *Trigonometrical Survey*, Vol. 2, p. 187, the latitude of Blenheim by observation is stated as $51^{\circ} 50' 24''.9$ or nearly $51^{\circ} 50' 25''$.

The measured distance, on the meridian, from Blenheim to Arbury, is 139822, deduced from Vol. 2, part 2, p. 107; dividing this distance by 60881.7, according to a table in Vol. 1, part 1, page 168, corresponding to the middle latitude between Blenheim and Arbury, and multiplying the quotient by 10, we obtain the difference of latitude = $^{\circ} 22' 58''$. this quantity added to

-	-	-	-	51.50 25
gives for the latitude of Arbury	-	-	-	52 13 23

being *5'' less* than by the zenith sector. It is true that Colonel MUDGE corrected the latitude of Blenheim, from the *Trigonometrical Survey*, to $51^{\circ} 50' 28''$, and in this case the computed latitude of Arbury would come out near 3 seconds *less* than found by the zenith sector. In Vol. 2, part 1, page 118, the *latitude of Arbury*, as derived from Dunnose meridian, is given - $52^{\circ} 13' 26''.6$

afterwards $52 13 28 .2$ from observation*

$1 .6$ or $1\frac{1}{2}$ second *south* of the observed

* Vol. 2, part 2, page 109, Dunnose is stated to be $50^{\circ} 37' 8''.2$
p. 107, from Dunnose to Arbury is $1 36 10.98$

$52. 13. 28.18$

latitudes; all concurring to prove that the observed latitude by zenith sector falls to the north of the calculated, or that the deflection of the plumb-line was to the south: taking, therefore, the table above referred to in Vol. 1, part 1, p. 168, and considering the latitudes of the following stations to be as below:

Dunnoe	$51^{\circ} 37' 0''$
Greenwich	$51^{\circ} 38' 39\frac{1}{2}''$
Blenheim	$51^{\circ} 50' 28\frac{1}{2}''$
Arbury	$52^{\circ} 13' 26\frac{1}{2}''$
Clifton	$53^{\circ} 27' 30\frac{1}{2}''$

and calculating the length of a degree, in their respective middle points, they will be found to correspond with the said table, and maintain a regular increase to the northward, agreeing with the assumed general figure of the earth: the above assumption indicates an error of $10\frac{1}{2}''$ at Clifton, and $1\frac{1}{2}''$ at Arbury, neither of which is more than might be expected from the visible inequality of the contiguous land.

The result of the operations north of Clifton I have not had an opportunity of ascertaining; but it appears to me that a few more observations by the zenith sector, at other stations, would remove much of the apparent ambiguity at present attached to this interesting question.

Knowing the goodness of the instrument used in the Survey, and the great skill and attention observed by the persons engaged, I have great confidence in the general result of the terrestrial department. I should have been doubly gratified if I could have said as much on the determination of the heights of the stations.

Availing myself of the levels through a long district of the

Grand Junction Canal, I have been at the trouble of levelling from the following stations, viz.

Wendover Down,
Kensworth,
Bowbrick Hill, and
Arbury Hill,

to the nearest point of the said Canal, and thus, by means of the known level of the different parts of the Canal, to obtain the *relative heights* of the above mentioned stations.

And as a comparison will be more readily made from a table of heights expressed in positive numbers, I shall assume the highest point of the summit of said Canal to be 402 feet above the level of the sea, at low water spring tides; with this assumption, the heights of the several stations, in feet, above low water mark, will be as follows :

Wendover Station	- - - -	861
Kensworth ditto	- - - -	809½
Bowbrick Hill	- - - -	571½
Arbury Hill	- - - -	740½

The heights of these Stations published in the Philosophical Transactions, are as below : in Vol. 3, page 302.

Wendover	- - - -	905
Kensworth	- - - -	904
Bowbrick Hill	- - - -	683
Arbury Hill	- - - -	804

these will average about 78 feet higher than in the table above.

I have also levelled from the summit of the Regent's Canal, to the mouth of the fixed cannon at King's Arbour, or the upper end of the base on Hounslow Heath, and upon the same data this point will be 90½ feet above low water mark.

In Vol. 1, p. 173, Colonel MUDGE gives $91\frac{1}{2}$ for its height, which differs only by half a foot.

But at page 266 it is stated to be 118 feet, being 27 feet above the proper height. Again in Vol. 3, p. 307, it is stated to be 132 feet, or $41\frac{1}{2}$ too high.

The grounds of my assumption of 402 feet being the height of the Grand Junction Canal summit, near Tring, are these:

The range of tide, from low water spring tides at sea, to high water near Somerset House, I presume to estimate $19\frac{1}{2}$ feet; from this point to the Regent's Canal summit will be found $83\frac{1}{2}$ feet; from this level I apply the revised section of the Grand Junction Canal = $299\frac{1}{2}$ to the summit near Tring, making together 402 feet as above.

From these levels it will appear, that Wendover Station above Brickhill is $861 - 571\frac{1}{2} = 289\frac{1}{2}$. Colonel MUDGE's numbers give - - $905 - 683 = 222$
 $67\frac{1}{2}$ error.

Arbury above Brickhill $740\frac{1}{2} - 571\frac{1}{2} = 69$
 Colonel MUDGE - - $804 - 683 = 121$
 Error 52

Wendover above Arbury $861 - 740\frac{1}{2} = 120\frac{1}{2}$
 Colonel MUDGE - - $905 - 804 = 101$
 Error $19\frac{1}{2}$

Some fresh observations with the zenith sector made at Blenheim, and Sutton, would offer a fine check to the latitude of Arbury; and also at Highbeach, and Botley Hill, a check to the latitude of Greenwich would be readily obtained.

B. BEVAN.

Leighton, Bedfordshire,
 February, 1822.

IX. *On some Fossil Bones discovered in Caverns in the Limestone Quarries of Oreston.* By JOSEPH WHIDBEY, Esq. F.R.S. In a Letter addressed to JOHN BARROW, Esq. F.R.S. To which is added, a Description of the Bones by Mr. WILLIAM CLIFT, Conservator of the Museum of the College of Surgeons.

Read February 6, 1823.

DEAR SIR,

Plymouth, 19th August, 1822.

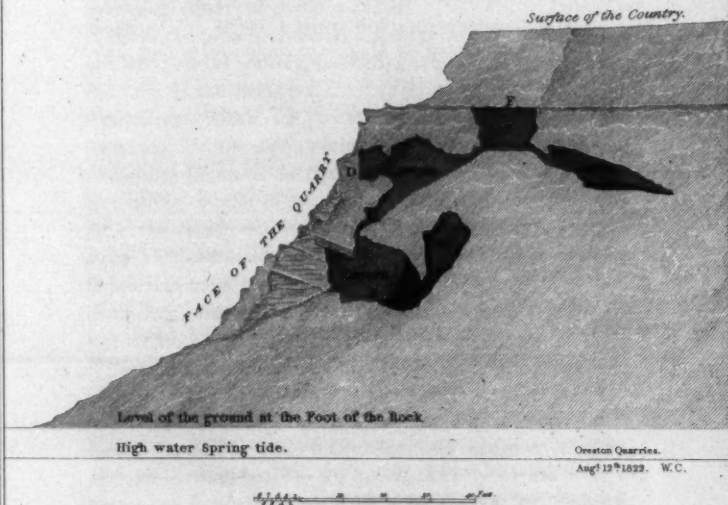
IN continuing to quarry the lime-stone rock at Oreston, in Catwater, near Plymouth, for the use of the Breakwater, the workmen came to another cave, containing many teeth and bones, which I have sent to you to be disposed of as you may please to direct for the benefit of science, this being the third cave, found in these quarries, containing teeth and bones: an account of the two former have been already published in the Philosophical Transactions.

It is not my intention to give any description of the fossils now found, but I shall content myself with merely describing the situation in which they were discovered, together with the state and appearance of the rock.

The height of the rock, or quarry, is about 93 feet above the top of high water of spring tides, which is shown in the sketch No. 1, [Plate VI.] together with a section of the caves where the bones were found. The part where they lay is tinged with red, in the caves marked A. and B. The cave A, is encrusted with thin stalactite, some pieces of which

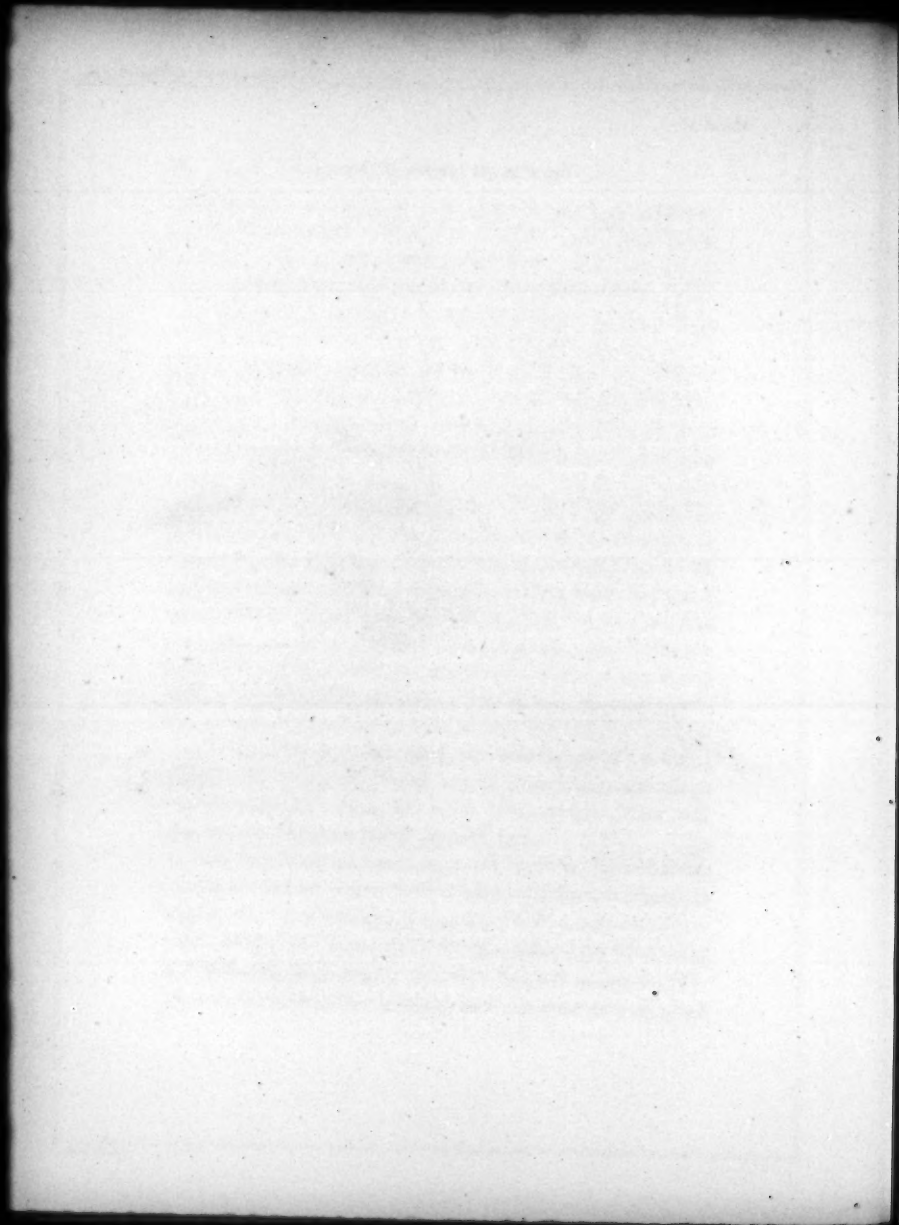
Sketch N^o 1.

*A LONGITUDINAL SECTION of the CAVERNS
lately discovered in the
BREAKWATER QUARRIES at ORESTON.*



REFERENCE

*The distance from the entrance of the Caverns
to the Original high water mark is 201 Yards.
The dark Tint on the Section describes the places
where the Bones were found.*



are in the case No. 2. The cave B mostly consists of limestone, with bones adhering to its sides: the top is closed up with stone rubble. The teeth and bones found in the cave A, were mostly covered with dirt, some of which will be found in all the cases; part of the bones were lying on the dirt, and in crevices about the caves A and B.

From the cave marked A, a passage has been discovered into what I call a gallery, marked C, which gallery opens into the face of the quarry at D. At E, some teeth and bones were found, which are contained in the case No. 5. The farther end of the gallery is not closed, but it is not sufficiently wide for a man to creep into it. The sides of the gallery consist mostly of lime-stone, some clay, and stalactite. At F, the gallery was covered with masses or lumps of limestone, with much clay intermixed, and in general so compact that it required gunpowder to blast it asunder; and continued so to the surface of the country, a height of 15 feet, as shown in the sketch.

The general state of this quarry has been found to consist of more caves filled with clay, than any other; and nearly under the entrance of the cave where the bones were found, I have dug down through clay of so stiff and hard a nature as to render it difficult to dig into it, and it continued so until I got to six feet below high water, when rock again appeared, but not compact. In this digging many lumps of iron ore were found in the hard clay.

I have introduced a scale into the sketch, from which any distance may be measured.

The distance from the cave A, to the commencement of the quarry or harbour, is 201 yards, and to the cave where

the first bones were found in November, 1816, 180 yards in a western direction.

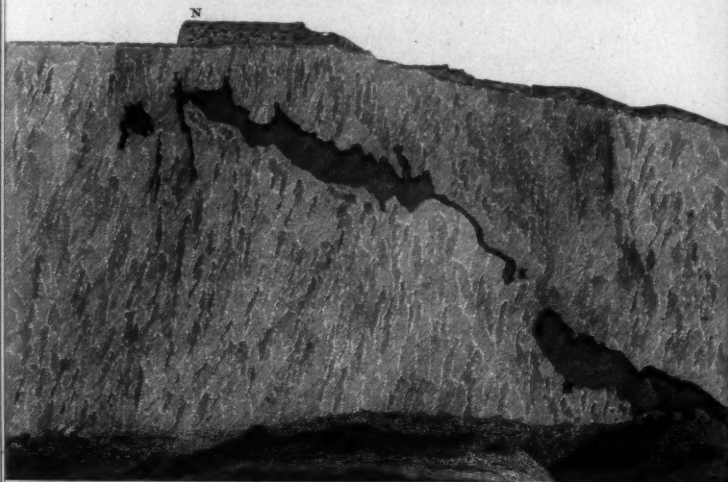
The sketch No. 2, [Plate VII.] shows the face of the rock where the teeth and shells were found, which are in the case No. 8, with some of the clay and sand in which they lay. The face of the rock is very compact lime-stone, excepting the part shaded dark. In the lower part of it is a cave marked G, H, I, filled with the substance that will be found in case No. 8. In this cave the teeth were found at G, and the shells at H. Between I and K, the rock appears to be compact, but from K to L it is composed of narrow fissures, covered with thin stalactite throughout. At M, there is a small opening of but little extent; above and below which, and the fissures marked K and L, as well as the cave marked G, H, I, there is no apparent opening to lead to the surface, more than what I have mentioned in my description of sketch No. 1; but what may be produced in quarrying farther on I cannot tell, though I shall not fail to take notice as the quarry proceeds.

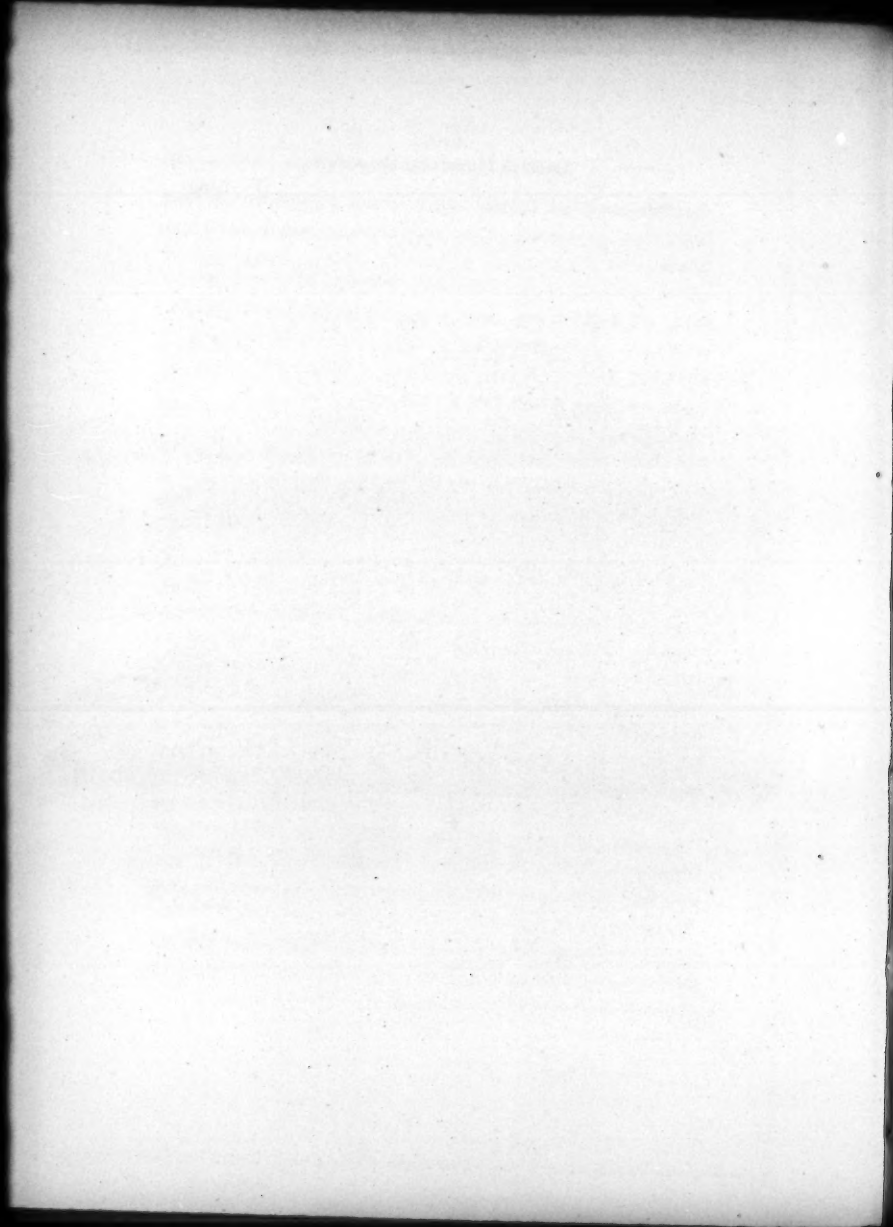
The height of this quarry to the surface at N, is 110 feet; and this part of the quarry is 400 feet distant from the cave A, in sketch No. 1, and is in fact part of the same quarry.

Professor BUCKLAND and Mr. WARBURTON have examined the Oreston quarries and caves that contained the bones, and they also found some themselves.

This body of lime-stone rock commences at Mount Edgecombe, crosses the east end of the Dock-yard, and takes the line of road towards London, and I believe ends at Chudleigh, as I have never seen it to the eastward of that place. Both sides of Torbay are of lime-stone, but it continues no farther to the eastward in that direction. In what manner

Sketch N° 2.





the lime-stone at Torbay is connected with Plymouth and Chudleigh, or whether it be connected or not, I am unable to say,

I am, DEAR SIR, &c. &c.

JOSEPH WHIDBEY.

N. B. Since the bones were packed up, another jaw bone has been found, more perfect than any I have seen, with most of the teeth in it. This was found in cave B, where many of the other bones were discovered.

A description of the Fossil Bones found in the Caverns of Oreston, referred to in the foregoing Paper. By Mr. WILLIAM CLIFT, Conservator of the Museum of the Royal College of Surgeons, in which the bones are deposited.

On receiving this large collection of fossil bones for the purpose of comparing them with those of recent animals, and with other specimens, now deposited in the Museum of the College, which were discovered in caverns in the same lime-stone rock in the years 1816 and 1820, I immediately perceived that they belonged chiefly, if not entirely, to animals of different genera from those formerly met with; and consequently, I became desirous of ascertaining how far they were similarly circumstanced in regard to the relative situations in which they were found; because in the caverns first discovered, the bones of the different species were entirely separate from each other.

In the cavern discovered in 1816, although the greatest care was taken to collect every bone contained in it, those of the rhinoceros alone were found.

In those of 1820, one cavern contained bones and teeth of the bear; while another contiguous cavity, of apparently coeval formation, contained only bones of a deer or antelope; but of which, the genus could not be positively ascertained, as neither the teeth, nor horns, nor any part of the head were found.

In the caverns discovered in 1822, which form the subject of the present communication, the bones of animals of several distinct genera were found; namely, the bos, the deer, the horse, the hyæna, the wolf, and the fox. These cavities, however, communicated with each other, and the bones of the different graminivorous animals were found mingled together in the same cavity; but those of the carnivora at a considerable distance from each other; the bones of the hyæna having been discovered in the cavern marked B in the annexed plan, and those of the wolf and fox in the gallery marked E.

Some of the bones and fragments of bones which lay on and near the surface of the clay, have acquired a thin crust of stalagmite, but in none of them does it appear to have penetrated beyond the surface: the greater number were imbedded in the stiff clay, which adhered so firmly to them, that many were broken by the workmen in separating them from the matrix; and others have fallen to pieces since their exposure to the air; but a great proportion of the cylindrical and other bones, of the graminivorous animals in particular, are still as perfect in form as at the time of the death of the animals to which they belonged, and do not exhibit the least appearance of having been gnawed or otherwise mutilated.

The only specimen in this very large assemblage which

bears any apparent marks of teeth, is a portion of the radius of a young wolf, which, in two or three places on its surface, has the impression of the incisors and canine teeth of some small animal of the size of a weasel.

The clay still adhered so firmly to the surface of many of these bones, that unless removed with considerable caution, the outer layers separated along with it, and showed that but little animal matter remained; and on submitting some of these fragile portions to the action of dilute muriatic acid, they almost intirely dissolved, leaving scarcely any trace of animal matter. In this respect there is a considerable difference in various specimens. In some comparative trials made by Professor BUCKLAND, although the proportion of animal matter was greater than in my experiment, he found that these bones contained about one-third part less than the bones from the cavern at Kirkdale.

Is it not therefore probable, that the clay immediately surrounding the bones, which is of a darker colour as well as more tenacious than that in which no bones were found, may have abstracted a large proportion of the animal matter, and be the principal cause of the extremely fragile state of the bones? for they are now so absorbent, that if the largest of them be applied to the surface of the tongue, they adhere so firmly as to support their whole weight. In this, they resemble those bones which were discovered in 1816, and 1820; most of them being as white and fragile as though they had been calcined.

It would appear that the loss of animal matter, and consequent decay or decomposition of fossil bones, depends very much upon the nature of the soil in which they are deposited,

and on its elevation, and different degrees of moisture at different periods; and perhaps, in a great measure on the density or compactness of the bones themselves. There are specimens in the Museum of the College of Surgeons, of sections of teeth of the animal incognitum, or mastodon, from the blue clay on the banks of the Ohio; and of the bear from the caverns at Gaylenreuth, which have retained their animal matter so entirely, as to preserve their form most perfectly, after having been deprived of their earth by means of muriatic acid, while, under other circumstances, teeth and bones of the densest kind, lose their cohesion immediately after being exposed to the air, and becoming dry. This is constantly the case with the tusks, molares, and other bones of the elephant, so frequently found in the yellow sand above the blue clay at Brentford, Ilford, and other situations in the vicinity of the River Thames; which invariably separate into small lozenge-formed or cubic fragments as soon as they become dry.

On immersing the bones of the carnivorous animals in water, more effectually to remove the clay without injuring the surface, they effervesced strongly, and became nearly of a black colour, but recovered their former appearance on drying. A similar effect was produced, but in a less degree as to colour, on the bones of the bovine animals, and of the horse.

It may be worthy of remark, that appearances of disease in fossil bones are of rare occurrence; and I have never yet seen an instance of fracture that had been united during the life of the animal: but among these occur two examples in the metacarpal and metatarsal bones of the bovine animals,

which unequivocally show the effects of ossific inflammation on their surface; (Fig. 1.) and the lower jaw of a young wolf, in which an abscess on each side had produced sinuses, and a considerable alteration in its form and texture.* Fig. 2, and Fig. 3.

All the bones from these caverns which have come under my observation, are clearly referable to animals of known, and still existing genera, as will appear by the following enumeration: but it is a curious circumstance, that, with the exception of the very few belonging to the deer, they all appertained to animals entirely differing from those found in the immediate vicinity in the former instances.

Of the bovine genus, there are specimens of the bony core of the horns belonging to three individuals of different size; (Fig. 4.) all of them remarkably short, conical, and slightly curved, and standing in a nearly horizontal direction from the head. They evidently do not belong to very young animals, and from the appearance of these alone, a very small species would be inferred; but numerous specimens of the teeth, of the os humeri, ulna and radius, os femoris, tibia, os calcis, metacarpus and metatarsus, and phalanges, (Fig. 5.) clearly prove that they belonged to individuals considerably larger

* On mentioning this circumstance to Professor BUCKLAND, he informed me that he had lately seen in the Collection of Professor SÖMMERING of Munich, the skull of a very old hyæna from the caves of Gaylenreuth, in which the incisor and canine teeth, with the jaw containing them, had been entirely torn away, and the occipital and parietal crest dreadfully fractured and perforated, apparently in an affray with some more powerful animal; after which, a healing, and partial renovation of the parts had taken place, and the animal had lived on to mature old age, from the state of its masticating organs.

than the average size of animals of that genus at the present day.

The number of bones collected, afford sufficient grounds for supposing them to have belonged to more than a dozen individuals, varying considerably in their age.

Of smaller ruminants, there are a few portions of the cylindrical bones belonging to one or two individuals, which are too imperfect to admit of being very satisfactorily identified, but apparently are those of a deer; and some others belonging to very young animals in which the epiphyses had not been united, and consequently the bones had not acquired sufficient distinctness of character to allow of our speaking decidedly concerning them; but they have been most probably those of a calf or fawn.

Of the horse, the bones are satisfactorily identified by various specimens of the teeth, the large cylindrical bones, the os calcis, metacarpus and metatarsus, first and second coronary bones, the sesamoid or nut-bone, and particularly by the terminal phalange or coffin-bone of the foot. (Fig. 6.) From the number of these there must have been twelve or more individuals of not less than fourteen hands high; one of the metatarsal bones measuring eleven inches and a half in length. Some of these animals, from the worn state of the teeth, appear to have been very aged.

Of the hyæna, there are bones and teeth which belonged to at least five or six individuals of various ages; some of them equalling the largest of those found at Kirkdale in 1820. Among these, is a part of the right side of the lower jaw, in which remain one of the shedding molar teeth, and

two permanent ones which had not sufficiently advanced in their growth to have protruded through the gum, but are still enclosed within their alveolar cavities. (Fig. 7.) Also part of the right side of the lower jaw of an adult animal, with the teeth in a good state of preservation. This specimen was discovered in the cavern marked B, in Plate VI.

There are likewise detached specimens of the canine teeth and molares of individuals of very large size: and the posterior part of a skull of uncommon magnitude, which corresponds most exactly in form with that of a hyæna, and must undoubtedly have belonged to that animal, but measures twice as much from every determinate point to another, as a recent full grown hyæna's skull. (Fig. 8.)

Of the wolf, there are some bones of several individuals which were found in the cavern marked E, Plate I. There are two large portions of the lower jaw, containing nearly all the teeth in good preservation, and perfectly agreeing in size, in form, and arrangement, with those of a full grown recent animal. (Fig. 10.)

The os humeri also is perfectly similar, and has the rounded aperture through its lower extremity to receive the curved process of the olecranon.

A few very small fragments of shell were found in the situation denoted by the letter H. Plate VII, apparently allied to the genus *ostrea*; but they are too minute to admit of even that being positively ascertained. A single valve would produce more than all the fragments in question: when applied to the tongue they do not adhere, and their pearly surfaces have all the compactness and lustre of a recent shell.

Since the above was written, Mr. WHIDBEY has transmitted some additional specimens of the jaws and teeth of the hyæna, the wolf, and the fox, which have been subsequently discovered in the cavern marked E, and from which cavity all the bones of the wolf have been derived. Among these is half of the lower jaw of a hyæna of very superior magnitude to any of those previously discovered, (Fig. 9), and probably has belonged to the large skull before-mentioned.

The jaws of the wolf are of similar dimensions with those before described; but one of them belonged to a very aged individual.

Of the fox, there have been found only a few vertebræ, and two canine teeth from the lower jaw, which correspond perfectly in size and form with those of a recent animal; but are equally fragile and absorbent with those of the other animals.

In a subsequent Letter of Mr. WHIDBEY to Mr. BARROW, relating to these last mentioned specimens, dated Plymouth, November 9, 1822, he communicates the following additional information:

"These, I think, will be the last bones I shall send you
"from these caves, as they are now nearly worked out. The
"cave B terminated near where it was first seen: the head
"of it was closed over with a body of lime-stone.

"The joints of the rock were not so close but that water
"might drop down into the cave; and about these joints
"some stalactites were found in small pieces. I have not
"seen any thing to encourage the idea that the cavern had a
"communication with the surface since the flood; the present state of the quarries shows nothing like it."

EXPLANATION OF THE PLATES.

The figures are all of the natural size.

PLATE VIII.

Fig. 1. A posterior view of part of the right metatarsal bone of the bos, showing the effects of long continued ossific inflammation.

Fig. 2. Inside view of part of the lower jaw of a young wolf, in a diseased state from abscess.

Fig. 3. Outer view of the same jaw.

PLATE IX.

Fig. 4. The bony core of the left horn, and a small part of the skull, seen from behind. It is the middle-sized specimen, and most perfect of the three.

Fig. 5. The lower extremity of the metacarpal bone and the three pair of phalanges of the bos, viewed anteriorly.

PLATE X.

Fig. 6. The two coronary bones and the terminal phalange or coffin-bone of the foot of the horse.

Fig. 7. An outside view of part of the lower jaw of a young hyæna, in which remains one of the temporary or shedding molar teeth, and two permanent ones not perfectly formed, and consequently had not yet cut the gum.

PLATE XI.

Fig. 8. An oblique view of the posterior part of the skull of
MDCCCXXIII. N

a very large hyæna, in which the parietal and occipital crest is greatly extended to afford surface for the attachment of muscles.

PLATE XII.

Fig. 9. An outside view of the left side of the lower jaw of an hyæna of very large size, where the teeth are considerably abraded by masticating hard substances.

Fig. 10. An outside view of part of the lower jaw of a wolf, which corresponds most exactly in number, form, and size, with those of a full grown recent animal.

Fig. 1.



Fig. 2.

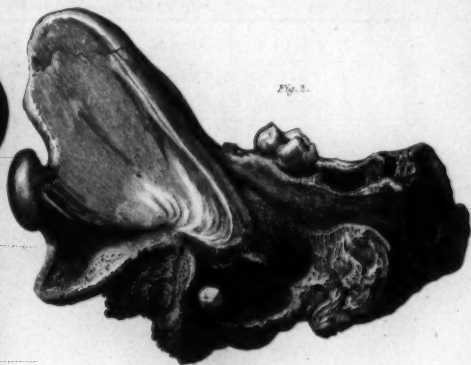


Fig. 3.

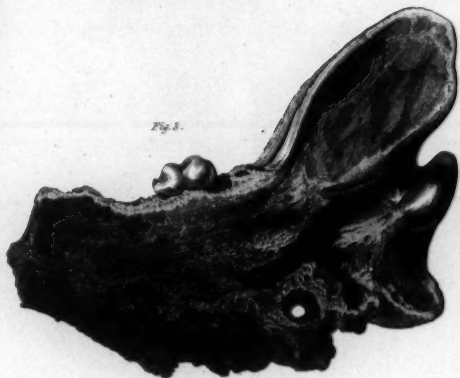




Fig. 4.



Fig. 5.





Fig. 6.

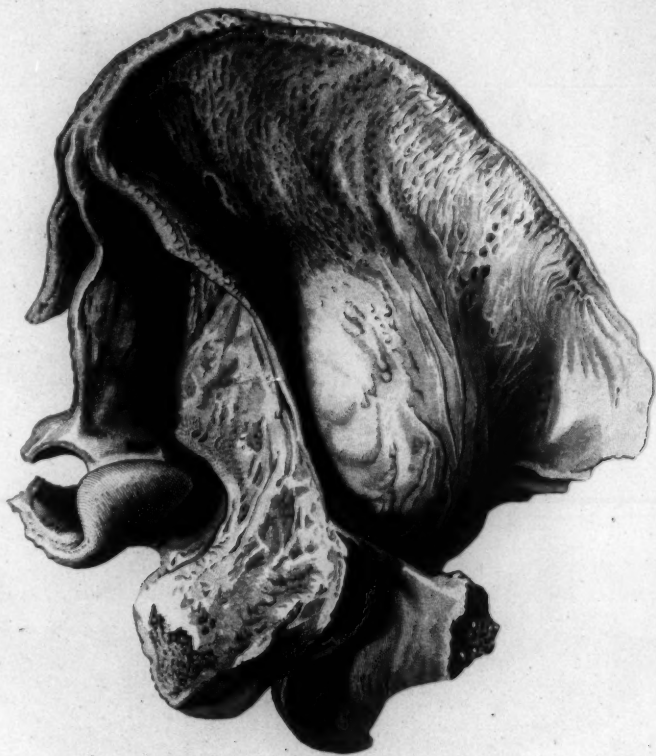


Fig. 7.





Fig. 8.





SECRETARY

Fig. 9.

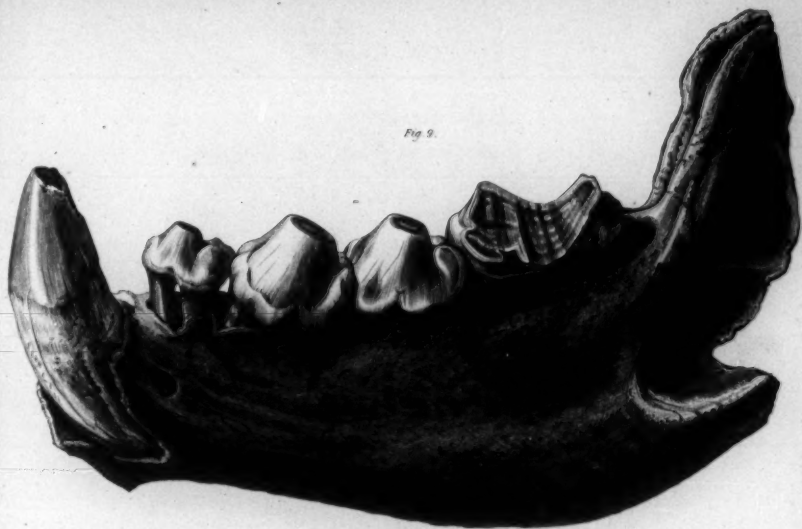
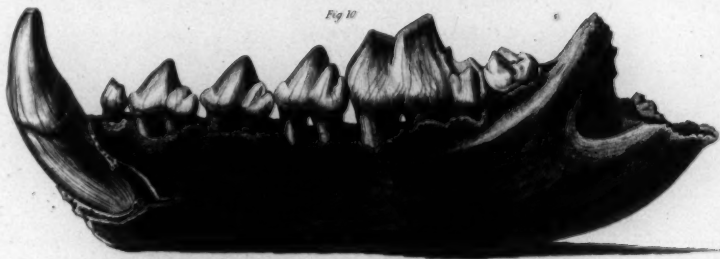
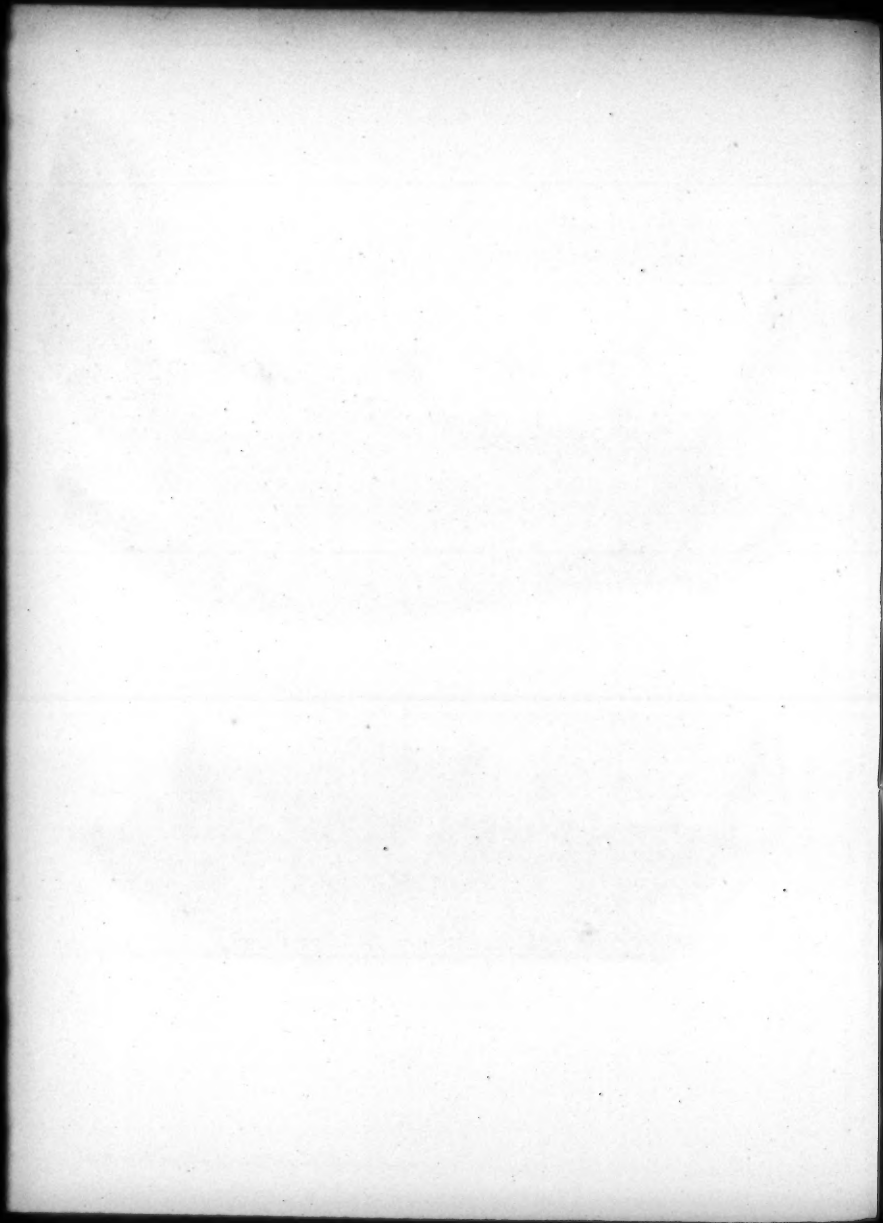


Fig. 10.





X. *On the Chinese Year.* By J. F. DAVIS, Esq. F.R.S.

Read December 19, 1822.

ALL investigation into the Chinese knowledge of astronomy tends only to prove, that before the introduction of that science into the empire, first by the Arabians, and afterwards by the European missionaries, they were wholly ignorant of its principles. It is true that CONFUCIUS has recorded thirty-six eclipses of the sun, the greater number of which have been verified by the calculations of European astronomers: but, as has been very truly observed, the *recording* an eclipse may prove the authenticity of historical annals, while, at the same time, it proves nothing as to the existence of astronomical science. As far as related to the mere *observation* of the sky, the Chinese have, from the earliest periods, been very particular and assiduous. The remark of DU HALDE, that "all these observations are not a little serviceable in ascertaining their chronology," is very true, but they by no means prove (what he sometimes appears desirous to establish), that the Chinese were astronomers.

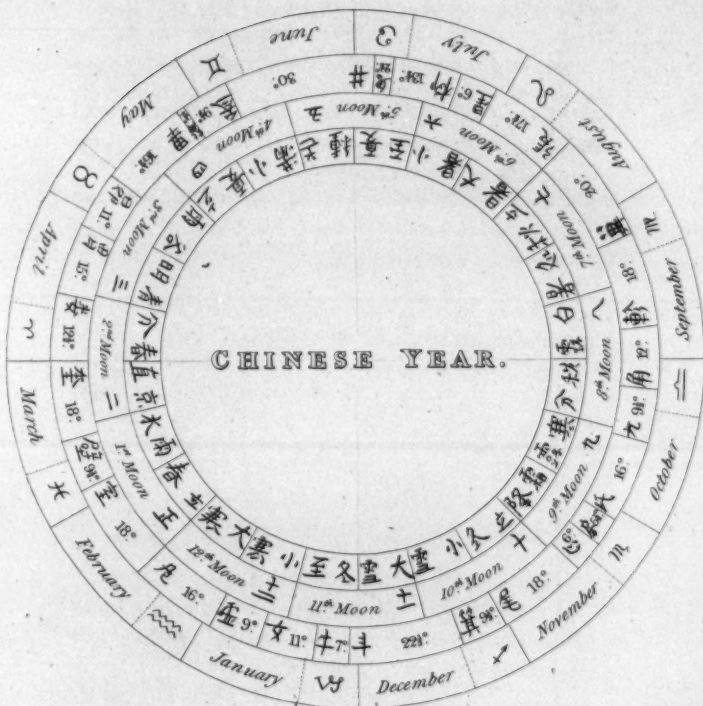
On this one subject, that singular nation has deviated from its established prejudices and maxims against introducing what is foreign: and that a people so self-sufficient and vain, should at once, in open violation of their general practice, have adopted the science of foreigners, and raised its professors to high dignities, is the strongest possible proof that they had no science of their own.* It even appears

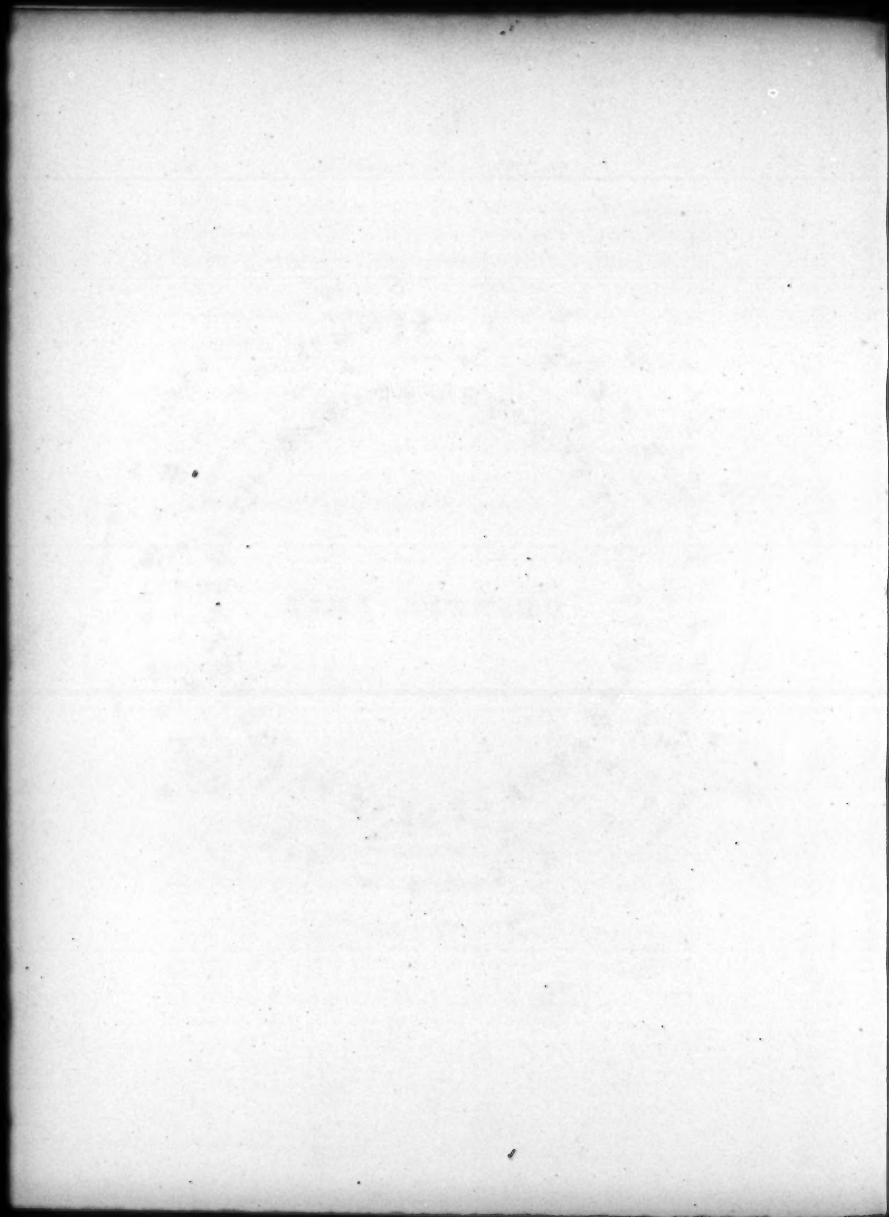
* The most sensible estimate of the extent of Chinese knowledge has been made by REAUDOT, in his observations on the accounts of the Arabian travellers.

that they have in former times adopted the very errors of European astronomy. The writer of this discovered, in an old Chinese book, the most exact delineation of the Ptolemaic system, with its crystalline orbs, primum mobile, &c. &c. and the earth occupying a conspicuous place in the centre of all. Indeed it is impossible not to smile at the idea of attributing any science to a people whose learned books are filled with such trumpery as the diagrams of Fo-hi, and a hundred other puerilities of the same kind.

There cannot be a doubt that the instruments mentioned by DU HALDE, as having been found by the missionaries on their first entrance into the country, were constructed by the Arabians. His observation, that "the uses of these instruments were written in Chinese characters, with the names of the constellations, which are 28 in number," proves nothing to the contrary. The guns which were cast for the Chinese by Europeans, were always inscribed with Chinese characters; and the ungrateful vanity of that people has invariably led them, when they have borrowed any thing from foreigners, to conceal the debt as much as possible. In proof of this, the writer is able to state the following fact: when Mr. PEARSON made them his invaluable present of the vaccine inoculation, it was accompanied by a small pamphlet in Chinese, containing a few necessary directions as to the use of the virus, and stating the discovery to have been English. An *expurgata* edition of this little book was very soon after published, in which not one word was retained as to its origin, nor any trace by which it could be known that the discovery of vaccination was otherwise than Chinese.

In the accompanying view [Pl. XIII.] of the Chinese year, are marked down, in the outer circle of all, the signs of our





European zodiac, for the sake of comparison; and in the second circle is described *their* zodiac, or the twenty-eight constellations, with the same number of degrees affixed to each, as are given to them in the Chinese books, making 360 in all. It will be observed that they are extremely unequal, the largest, 井 *tsing*, consisting of 30 degrees, and the least, 觜 *tsuy*, of not more than about half a degree. Of these 28 constellations, 角 *Kiö*, denoted by Spica Virginis, is considered as the first in order.*

In the circle next to the constellations are noted the Chinese moons, or months, of which 正 *ching* is the 1st, 二 *urh* is the 2nd, &c.: and in the innermost circle are described the 24 *Tsië-ky*, or divisions of half moons, each consisting of about 15 days. Their names have a reference to some prevailing circumstance in each season, as 雨水 *Yu-shuy*, "rain and water," 清明 *tsing-ming*, "clear and bright," 大雪 *ta-siü*, "much snow," &c.

The Chinese, as far as the writer of this knows, have no solar year, unless their celebration of a grand festival at the 冬至 *tung-chy*, or winter solstice, may be considered as an observance of its annual limits. DU HALDE says, that

* These constellations are generally found written on the Chinese compass, together with the diagrams of Fo-hi, the five elements (viz. fire, water, wood, stone, and metal, a division strikingly philosophical) and various other characters used in fortune-telling.

"their (solar) year is composed of 365 days and somewhat less than 6 hours, and from an epocha regulated by the winter solstice, which was the fixed point of their observations, as the 1st degree of Aries is of ours, reckoning from a hundred to a hundred degrees, they calculated the motions of the planets, and adjusted all things by equation tables: some supposed that they received them from the Arabians, who entered with the Tartars into China." He afterwards acknowledges, that "though the Chinese have distinguished the course of the sun into 365 days and 15 minutes, of which we compose one year, they regard more the lunations, than the course of the sun."

The Chinese year, properly considered as such, is in fact a lunar year, consisting of twelve months of twenty-nine and thirty days alternately, with the triennial intercalation of a thirteenth month, to make it correspond more nearly with the sun's course.* It has not been discovered (with any degree of certainty), *why* they fix upon the 15th degree of Aquarius as a rule for regulating the commencement of their lunar year: but they have an annual festival about the recurrence of this period 立春 which bears a considerable resemblance to the deification of the bull Apis; and this resemblance is increased by the connection of both ceremonies with the labours of agriculture, and with the hopes of an abundant season.† This coincidence may serve to fortify the opinions of those who are fond of tracing the Chinese to the Egyptians; although the possibility of such a derivation has been ably disproved by M. DE PAUW.

* I call this intercalation triennial, because that is the nearest approximation; but in fact it is seven times in nineteen years.

† For a detail of the Chinese ceremony, vide MORRISON's view of China, p. 109.

An astronomical work, in which the writer of this found the Chinese planisphere, comprised in 12 charts of the heavens, mentions the N. Pole as being 36° above the horizon, and hence he concludes, that what it contains is independent of the astronomy which was afterwards introduced by the European Missionaries, because, as the elevation of the pole at any particular place is the latitude of that place, it is probable the contents of this book were compiled when the Chinese Court and observatory were in Honan, a part of which province is as high as 36° N. It appears from Du HALDE, that the astronomical instruments, mentioned above as having been constructed by the *Arabians* for the Chinese, were calculated for 36° latitude.

Mr. REEVES, of Canton, has with much labour compared the modern Chinese planisphere with the European constellations, and his catalogue of stars is printed at the end of Dr. MORRISON'S Dictionary.

J. F. DAVIS.

XI. *Experiments for ascertaining the Velocity of Sound, at Madras in the East Indies.* By JOHN GOLDINGHAM, Esq. F. R. S.

Read February 20, 1823.

THE manner in which sound is conveyed, and the theory of its velocity, are too well known, and are to be found in too many scientific works, to need detailed repetition here. The actual rate of its motion, particularly in different states of the atmosphere, does not appear, however, to have been so well agreed upon by Philosophers. A scientific writer* in a standard work, states "That some of the most eminent philosophers, judging that the knowledge of the flight of sound might be of use on various occasions, have been at extraordinary pains and expense to measure the rate at which it moved; and the result of their experiments, particularly of those which were best conducted, is as follows:

1. "That the velocity of sound is the same, whether by sea or by land, in dry or in rainy weather, by day or by night, in winter or summer.
2. "That sound, whether more or less strong, flies with the same swiftness. For, by experiments, a cannon fired with a half-pound charge of powder was heard at about the distance of seventeen miles and a half in the same time after the flash was seen, as it was when fired with a charge of 6lbs.

* ROBERTSON.

3. "That the times in which sound is heard are proportional to the distance; that is, at a double distance it is heard in twice the time; at a triple distance in thrice the time," &c.

This, however, is not supported in *all* points by the experiments I am about to detail; nor indeed could we expect it would be, from the manner in which sound is conveyed; as this leads us to the conclusion, that the more dense, and the less elastic, the atmosphere, the slower sound would travel.

The velocity of sound has been variously given by different philosophers, as the following table,* originally from the Philosophical Transactions, will tend to show.

	Pedes.	
D. Is. Newton, Eq. Aur.	968	Prin. Ph. Nat. Math. L. 2 Prop. 50.
Nobilis D. Roberts - -	1300	Philos. Transact. No. 209.
Nobilis D. Boyle - -	1200	Essay of Languid Motion, p. 24.
D. Walker - - -	1338	Philos. Transact. No. 247.
Mersennus - - -	1474	Ballistic Prop. 39.
D. Flamsteed and Halley	1142	
Florentini celebres - -	1148	Exp. per Acad. del Cinea p. 141.
Galli celebres - - -	1172	Du Hamel Hist. Acad. Reg.

To these may be added the following results of more modern experiments and calculations.

In Chili the thermometer 73,5, barometer 27,44 in. sound was found to travel 1227 feet in a second. By Mr. MILLINGTON 1130 feet.

Mr. RICHARD VAN REES has shown theoretically that the velocity of sound in common air is 341,54 metres in a second.

Mr. BENGENBERG at Dusseldorf, by experiment, 333,7 metres, about 2 feet and a half more, it is stated, than the velocity obtained at Paris by experiment.

* Being a portion of a dissertation by Mr. DARRHAM, who, if I recollect right, makes the velocity the same as FLAMSTEED and HALLEY.

A metre, according to the accurate investigations lately made in England, contains 39,370.79 English inches, and therefore 341,54 metres will be equal to 1120, and 333,7 to 1094,8 English feet.

"Some curious experiments were made relative to sound by Messrs. DE THURY, MARALDI, and DE LA CAILLE, upon a line 14636 fathoms in length, having the tower of Mount Lheri at one end, and the pyramid of Montmartre at the other extremity, their Observatory was placed between the two objects. The result of their observations was, that sound moves 173 French* fathoms in a second when the air is calm: 2. That sound moves with the same degree of swiftness whether it is strong or weak, an explosion of half a pound of powder discharged in a box, having been heard in the same space of time, as the report of a great gun charged with nearly six pounds of powder; 3. That the motion of sound is uniform, its velocity neither accelerating nor diminishing through the whole course of its progress. 4. That sound travelled at the same rate, whether the gun be pointed perpendicular to the horizon, or *towards* the person who hears the report, or *from* him — by other experiments however, the progress of sound appeared to be impeded by a strong wind." Dr. G. GREGORY, *Econ. of Nat.*

The velocity in the foregoing table, stated to be Sir ISAAC NEWTON'S, does not agree with that given by himself, which is 979 feet; this however is not deduced from experiment, but from the theory, no regard being had to the thickness of the solid particles of air, through which sound is propagated. This being allowed for, according to the formula,

* Or 1106½ English feet.

brings out the velocity of sound greater in the proportion of ten to nine, or 109 feet more, making the velocity 1088 feet; besides, vapours are dispersed through the air, which being of a different tone and elasticity, do not partake of the motion of the true air, by which sound is propagated; and it is also demonstrated, that the motion of sound will be quicker in such an atmosphere than in an atmosphere of true air, in the ratio of twenty-one to twenty; then the velocity last found being augmented in that proportion, we shall have 1142 feet for the velocity of sound in a second, according to Sir ISAAC NEWTON's theory.

LA PLACE, using the Newtonian formula, which he considers correct, and a theorem which he gives, makes the velocity of sound in a second 345,35 metres (or 1135,06 feet English) the temperature being 49°. The French Academicians, as before mentioned, found the velocity 337,18 metres, or 1106½ feet English. By experiments of LACAILLE the velocity was 344,42 metres, 1130,1 feet English, but the temperature is not mentioned.

In the above enumeration of the velocity of sound, given by different philosophers, very considerable discordances are observable; the actual reason of which cannot, I imagine, be discovered without the details of the experiments, and these are not in my possession; but probably, a particular examination of the experiments I am about to submit, may furnish a clue for the discovery of the cause of these differences. HALLEY and FLAMSTEED are the only two, whose results agree with the theory; but I am not quite certain whether their results were deduced from theory or experiment. Be this as it may, the conclusion drawn from the experiments

made here agrees, in a very satisfactory manner, with that given by Sir ISAAC NEWTON's theory, and by the two other celebrated men just named.

Between the years 1793 and 1796 a considerable number of observations were taken by myself, and under my superintendence, at the Observatory, with the view of ascertaining the velocity of sound. Not having the exact distances of the guns from the station when I returned to England, I wrote for farther information upon the subject—which I had not obtained when I quitted Europe again. I therefore did not bring these experiments forward at the time; and having a more elevated station to observe from, by the erection of a new building, and the advantage of corroborating distances, by the trigonometrical survey carrying on under the superintendence of Colonel LAMETON, I entered upon the course of experiments about to be detailed. The former experiments (those of 1793 and 1796) were made with ARNOLD's chronometers, as were these now given. In examining works obtained from libraries here, since I closed these experiments, for information relative to the results of like experiments by other observers, I found a letter from Colonel BEAUFOY, in the *Annals of Philosophy*, addressed a few years ago to Dr. THOMSON; and recommending to be done in England, what, in all the essential points, has been performed here, as will appear by the following extract:

"It has frequently excited my surprise, as well as regret, and in which I am no wise singular, that use has not been made of the admirable Trigonometrical Survey, begun by the late General ROY, and continued with so much ability and attention by Colonel MUDGE and Professor DALBY, to

make experiments on the velocity of sound; and however experiments of this kind may have been neglected, it is hoped that the present Master General of the Ordnance, a near relation of the late scientific Captain PHIPPS, (afterwards Lord MULGRAVE) will, for the purpose of perfecting a branch of science, no less curious than useful, order a series of experiments of this nature to be undertaken, not only in the inland parts of the kingdom, but also on different parts of the Coast." He then mentions that the experiments should be made under different circumstances of the wind and weather, and at different times of the 24 hours, and proceeds to enumerate the stations where the experiments should be made. He recommends that pocket chronometers should be used, "which generally making five beats in two seconds, the velocity of sound could be determined to the fraction of a second;" and concludes by saying, "he has no doubt scientific foreigners would assist our countrymen in finding the time sound is travelling across that part of the Channel, where the shores are visible from each other."

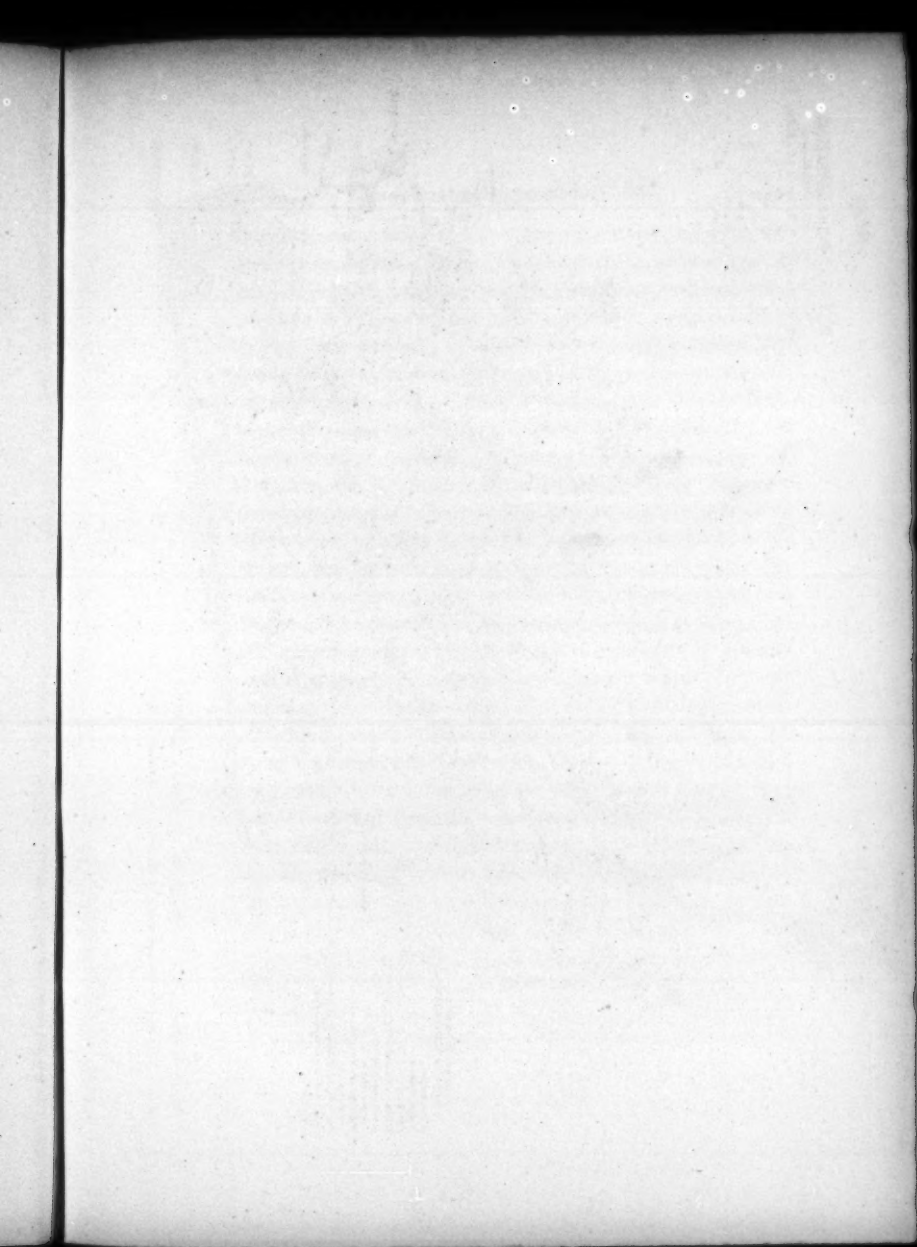
At Fort St. George (Madras) a morning and an evening gun are fired from the ramparts, as is customary in fortified places, the former at day light, and the latter at eight o'clock in the evening. At St. Thomas's Mount, the artillery cantonment, morning and evening guns are also fired, one at day light, and the other at sun set. The Madras Observatory, in latitude $13^{\circ} 4' 8''$ north, is situated between these; the distance of it from the Fort, about half its distance from the Mount, the Fort being to the N. E. of the Observatory, and the Mount to the S. W. In former years, as I have mentioned before, experiments were made by me for ascertaining

the velocity of sound, but were not brought forward. And a new building,* elevated so as to give a commanding view of the country, particularly of the Mount† and Fort‡, having been erected, I commenced a new series with the morning and evening guns of both places. The experiments with the Mount gun, it will be seen, comprise an interval, which embraces all the varieties of the wind and weather during the revolution of the sun; the interval with the Fort gun is less, in consequence of the morning and evening guns having been fired from different parts of the ramparts, after the date at which the Fort experiments close. All the experiments were made with chronometers, which had 100 beats in 40 seconds, sometimes by three observers, myself and two of the Observatory Bramin assistants, but generally by two: the observers having repaired to the station at the top of the Observatory building, a little before the expected time, and each holding his chronometer so that he could distinctly hear the beats, began to count the instant he saw the flash, and continued counting until he heard the report; the number of beats between the flash and report was then immediately put down upon a slip of paper, by each observer, without communication with the others, and the papers delivered to me for their contents to be registered; the height of the thermometer, barometer, and hygrometer, with the direction of the wind and state of the weather, were also observed at the time, and registered; and in this manner the whole of the

* The station on this building is about 55 feet above the level of the sea, distant in a direct line 4500 yards.

† The Mount gun is about 120 feet above the level of the sea.

‡ The Fort gun is about 30 feet above the level of the sea.



experiments were made. The situations of the guns with respect to the station from which the observations were taken, was very favourable, being in the direction, one of N. E. and the other of the S. W. monsoons—with the southerly wind and sea breeze, (both which prevail at certain seasons of the year,) blowing between the two. The guns used were 24 pounders, charged with 8lbs. of powder, and both pointed, not exactly towards the station, but in a direction not far from it.

The distances were ascertained with great care: first, by a survey made for the purpose, a base having been measured, and the angles taken with a grand circular instrument, similar to that used on the trigonometrical surveys.* Secondly, by using two or three of Colonel LAMBERTON'S distances and bearings found by the trigonometrical survey.

The results were thus deduced, and verified in different ways; and I have reason to think that the distances of the guns from the Observatory station are very accurately given. The mean of 12 results made the distance of the Mount Gun from the station 99547 feet; and the mean of 6 results, gave the distance of the Fort Gun from the station 13932,3 feet. The map† will show the exact relative positions and distances of the points, and the face of the country over which the sound travelled.

* I have not given the details of the survey, as that would swell the Paper to an inconvenient size: the base, however, was measured with great care twice, and generally six observations were taken for finding each angle, each observation differing very little from the other.

† The angles and distances were protracted, and the map of the intermediate country filled up from the best surveys, under the superintendence of E. LAKE, Esq. of the Madras Engineers, my son-in-law.

We see, as I before remarked, that the distance of one gun from the station is nearly double that of the other, and this will be found an advantage, in showing whether sound travels equally during its progress.

The experiments are given in the subjoined Tables.

Table I. Contains the experiments of each day with the Mount gun, together with the state of the atmosphere and the direction of the wind at the time of observation: the titles at the heads of the columns render a particular explanation unnecessary—the number of observers is stated in the third column, and the mean of their observations in the ninth.

Table II. Contains the mean of observations of each day, when the air was calm.

Table III. The mean of observations of three days, when the wind was in the S. E. quarter.

Table IV. The mean of observations of three days, when the wind was in the N. E. quarter.

Table V. The mean of observations of three days, when the wind was S.W. by W. or N.W.

Table VI. The experiments with the Fort gun, arranged as those in Table I., with the Mount gun.

Tables VII., VIII., IX., and X. The experiments with the Fort gun arranged according to the state of the wind, as in the former Tables of experiments with the Mount gun.

Table XI. Shows the mean motion of sound for each month at the Madras Observatory, as found by the experiments, at the mean height of the thermometer, barometer, and hygrometer, given in the table.

Upon a cursory inspection of Tables I. and IV., it will be seen that the motion of sound varies under different states of

the atmosphere and weather: that according to the first table, sound at one time has been as long as 27,6 seconds in travelling from the Mount to the Observatory station; and at another time only 24,8 seconds; the distance being 29547 feet. In the first case, therefore, the velocity of sound was only about 1078 feet in a second; while in the other, its velocity was nearly $1191\frac{1}{2}$ feet. The extremes in Table VI., show a still greater difference. This proves the necessity for making experiments during a long interval, in order to obtain an accurate general result.

In Tables II. and VII. we find, as the thermometer rose, the atmosphere at the same time decreasing in density and increasing in its elasticity, that the sound moved with greater rapidity.

That with the wind in the SE. quarter the velocity was considerably increased, both from the Mount and Fort; more, however, in proportion, as might be expected, from the former than the latter.

That with the wind at NE. the sound from the Fort gun travelled with a greater, and from the Mount gun with a less velocity, than when the wind was in any other direction; that wind being favourable for increasing the velocity from the Fort, and unfavourable from the Mount: the full effect of the wind, however, is not to be ascertained by this table alone, as the thermometer during the time the NE. wind prevails is comparatively low, and the barometer high; both which, as will have been seen by inspection of the tables, occasion the sound to travel slower than ordinary.

The wind SW. W. and NW. the velocity from the Mount was accelerated, and that from the Fort retarded; but not in

the degree that would have taken place had the thermometer, barometer, and hygrometer, remained the same as in the NE. monsoon; but having been different, the velocity was accelerated from both guns on this account, in like manner as it was retarded in the NE. monsoon.

The following are the results deduced from the experiments in the different tables. I shall first give the general results from Table I. and VI.

Mean height of Barom.		Thermo- meter.	Hygro- meter.	Seconds.	Distance.	Velocity in a Second.
Tab.	Inch.				Feet.	Feet.
I.	29,992	84,11	19	25,869	29,547	1142,18

Or almost precisely the same as the velocity by the theory.

Barometer.		Thermo- meter.	Hygro- meter.	Seconds.	Distance.	Velocity in a Second.
Tab.	Inch.		Dry.		Feet.	Feet.
VI.	30,066	80,47	11,4	12,306	13932,3	1132,14

Here we find a difference from the former general result by the observations with the Mount gun; the reason of which appears to be, that I could not, as I have before stated, carry on the observations during at least a complete revolution of the changes in the atmosphere; and that this is the reason I shall now endeavour to show. The interval wanting is between the 28th of March and the 16th of July. Had this interval been wanting in the experiments with the Mount gun, there would have been a difference of 0,237 seconds in the mean result; for the mean of the experiments in this

interval is $25''{,}632$, and the mean of the whole $25''{,}869$, making the difference just mentioned.

Now $25''{,}869 + 0''{,}237 = 26''{,}106$, which would have been the mean number of seconds had the observations with the Mount gun been continued during the same interval only as the experiments with the Fort gun. Then $26''{,}106 : 0''{,}237 :: 12''{,}306$ (the mean of the Fort observations) : $0''{,}112$. Now $12''{,}306 - 0''{,}112 = 12''{,}194$, which would have been the general mean of the experiments with the Fort gun, had the same been continued as long as the experiments with the Mount gun. Then the distance $13932,3$ feet, divided by $12,194$, will give $1142,5$ for the motion of sound by the experiments with the Fort gun thus brought on; and this also agrees, within a fraction of a foot, with the velocity according to Sir ISAAC NEWTON; and with the results by the two other celebrated philosophers before named. Feet

We then have by the Mount gun $1142,18$ for the velocity.

And by the Fort gun - - - $1142, 5$.

The mean is $1142,34$, or very nearly the velocity above alluded to. Nothing could be more satisfactory than this general result;* and it may be presumed, that the other results in different states of the atmosphere are equally to be depended upon.

The velocity also by the Fort gun, which, it will be recollected, is little more than half the distance of the Mount gun from the station, shows that sound travels equally during its progress.

In the N E. monsoon, the sound was very indistinct at times; this however does not appear to have sensibly affected

* The results by the Mount gun may however be taken as the standard.

its motion. The French academicians indeed proved, as I have mentioned before, that this made no difference in the velocity.

I shall now proceed to the conclusions from the other Tables; and first, those of the experiments with the Mount gun.

	Baro- meter	Thermo- meter.	Hygro- meter.	Wind.	Seconds.	Distance.	Velocity in a second.
Table	Inches.	°	°		"	Feet.	Feet.
II.	29,990	83,95	20,31	Calm	25,712	29,547	1149,2
III.	29,972	85, 5	19,96	SE	25,754		1147,2
IV.	30,113	81, 7	10, 9	NE	26,812		1102,0
V.	29,934	85, 1	26,	SW.W.&NW	25,374		1164,4

Secondly. The experiments with the Fort gun.

Table							
VII.	30,111	79, 3	11,85	Calm	12,313	13932,3	1131,5
VIII.	30,023	82, 3	14, 6	SE	12,231		1139,1
IX.	30,131	78, 6	7,33	NE	12,340		1129,0
X.	29,979	81, 9	11,41	SW.W.&NW	12, 46		1118,1

The results in these Tables, like the separate observations, show the necessity of making a series of experiments long continued, in order to obtain the correct general rate at which sound travels; and this may afford a clue, as I observed in the first part of this paper, for discovering the cause of the differences in the results by the authorities there named: it is difficult, undoubtedly, to ascertain the distance of two stations, one far from the other, to the nearest foot; but errors of many feet in this respect, would make but a small difference in the velocity in a second found by experiment, when

the gun and station were even at a moderate distance ;* we must therefore be led to conclude, that these differences have chiefly arisen from the experiments having been made during a limited period only, and at unfavourable times for obtaining a mean result, instead of the interval which appears by these experiments to be necessary.

A particular examination of the Tables and results, will show the difficulty of ascertaining what proportion of the differences should be allowed to each of the instruments used for finding the state of atmosphere, exclusive of the effects of the wind.

During the calms, we might expect that the proportional parts to be allowed for the difference in the thermometer, barometer, and hygrometer, might be found with some degree of accuracy ; the discrepancies, however, are very considerable. Comparing the results of Tables II. and VII. we find the barometer 0,121 lower, the thermometer $4^{\circ},6$ higher, and the air about $8\frac{1}{2}$ more dry by the former Table than by the latter, while the velocity in a second is only 17,7 feet greater by one Table than the other.

We give however in addition the following results taken from the Tables of calms, and arranged according to the different heights of the thermometer and barometer. These results may assist us in coming to some conclusion upon this part of the subject.

* For example, a difference of about twenty-six feet in the distance, between the Observatory station and the Mount gun, would make only about a foot difference in the velocity in a second.

* Experiments with the Mount gun.					
Baro- meter.	Thermo- meter.	Hygro- meter.	Seconds.	Distance.	Velocity in a Second.
Inches.	°	°		Feet.	Feet.
30,109	88,13	26,4	25,97	29,547	1137,7
29,889	88,	28,4	25,45		1160,9
30,140	77,16	11,5	26, 3		1123,4
30,089	81, 3	11,3	26,40		1119,2
29,915	84,96	20,3	25,81		1144,7
29, 93	82,12	16,0	25,91		1140,3
30,046	82, 9	18,9	25,75		1146,5
With the Fort gun.					
30,163	86, 3	23,8	12,27	13932,3	1135,5
30,135	74, 1	13,8	12,72		1095,3
30,063	80,76	8,8	12,11		1150,5
30,147	77, 5	10,8	12,57		1126,3
29,943	82,25	15,	12,15		1146,7
30,078	82, 4	10,4	12,35		1128,1

Where the changes are so numerous and so frequent as in the atmosphere of the earth, we cannot expect that our imperfect instruments will be of a construction sufficiently delicate to show accurately every alteration that may affect the motion of the pulses of the air; but by various comparisons and combinations of the results, we may hope to arrive at general conclusions, somewhat approaching the truth.

Now, by numerous combinations of the observations just given, when the air was calm, we are led to conclude: first,

* These are deduced from 100 observations.

that for each degree of the thermometer 1,2 feet may be allowed in the velocity of sound for a second; for each degree of the hygrometer 1,4; and for one-tenth of an inch of the barometer* 9,2 feet. Then taking these numbers as the basis of the comparison, we find the mean difference of the velocity between a calm, and in a moderate breeze of wind, to be nearly 10 feet in a second. And by comparing other results together, a difference of about $21\frac{1}{4}$ feet in a second, or 1275 in a minute is found between, the wind being in the direction of the motion of sound, or opposed to it.

Before I conclude these introductory observations, and explanations of the experiments, it may be proper to refer more particularly to Table XI., containing the mean motion of sound for each month of the year; by the experiments with the Mount gun, according to the state of the atmosphere indicated by the different instruments; and to the prevailing monsoons, which may be considered to be the same, during the same months, every year; full information respecting which is given in the former Tables. On examining this Table, it is rather curious to observe how regularly the mean velocity proceeds to a maximum about the middle of the year, and afterwards retraces its steps; giving us a velocity in one case 1164 feet in a second, and in the other of only 1099 feet. This regularity would, no doubt, be still greater with the mean of the observations of several years.

* The rise and fall of the barometer is very limited in this country, as will be seen by an examination of the Tables. A sudden fall of 0,3 inch indicates a gale of wind.

J. GOLDINGHAM.

Madras, 31st May, 1822.

Experiments for ascertaining the motion of Sound, with a gun placed on St. Thomas's Mount, station at the top of the Madras Observatory House.

Table I.

Month.	Day.	No. of Observations.	Morning & Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Beats.	Seconds.		
1820. July	14	1	E	h. 6	Inches.	°	Dry.				
					29,878	84,8	22	62,0	24,8	SE	Cloudy.
	15	1	E	6	29,910	83,5	23	62,0	24,8	SE	Cloudy and rain.
	16	1	E	6	29,900	83,5	18	64	25,6	Calm	Cloudy and rain.
	17	1	E	6	29,910	82,3	15	61	25,2	SE	Cloudy.
	18	1	E	6	29,842	84,3	17	64	25,6	Calm	Thin haze.
	19	1	M	5	29,870	79,8	12	62	24,8	Light NE	Cloudy and rain.
				6	29,865	83,3	14	63	25,2	SE	Hazy.
	20	1	E	6	29,855	84,0	15	63	25,2	SE	Clear.
	21	1	E	6	29,870	83,5	15	64	25,6	SE	Hazy.
	22	1	M	5	29,920	80,0	12	64	25,6	Land	Cloudy.
				6	29,900	80,4	14	62	24,8	SE	Hazy.
	23	1	M	5	29,920	80,5	14	63	25,2	Land	Cloudy.
				6	29,928	83,3	16	64	25,6	Calm	Cloudy.
	24	1	M	5	29,920	80,0	14	64	25,6	W	Hazy.
				6	29,915	83,3	16	63	25,2	SE	Cloudy.
	25	1	M	5	29,955	80,2	14	62	24,8	W	Cloudy.
				6	29,925	84,5	20	63	25,2	SE	Hazy.
	26	1	M	5	30,045	80,0	16	65	26,0	Light W	Hazy.
				6	30,018	87,0	24	63	25,2	Calm	Thin haze.
	27	1	E	6	30,048	83,3	20	63	25,2	SE	Hazy.
	28	1	M	5	30,055	80,7	15	65	26,0	Land	Cloudy.
				6	30,020	80,4	11	63	25,2	Light SE	Cloudy.
	29	1	M	5	30,020	79,8	9	65	26,0	SE	Clear.
				6	30,028	81,8	7	63	25,2	Fresh SW	Cloudy.
	30	1	M	5	30,040	77,8	7	64	25,6	Land	Clear.
				6	30,000	83,0	8	64	25,6	SE by E	Clear.
	31	1	M	5	30,025	81,0	8	62	24,8	Light SW	Clear.
				6	29,966	84,0	10	64	25,6	Light NE	Cloudy; some rain, thunder and [lightning.
Aug.	1	1	E	6	29,965	81,0	7	62	24,8	Calm	Clear.
	2	1	E	6	29,968	81,8	4	63	25,2	NW	Cloudy.
	3	2	M	5	30,020	80,2	4	63,5	25,4	W	Cloudy.
				6	29,975	82,5	6	63,0	25,2	Light SE	Thin haze.
	4	1	E	6	30,000	82,0	9	64	25,6	SE	Clear.
	5	2	M	5	30,030	80,0	7	64	25,6	Calm	Cloudy, and some rain.
				6	29,968	82,0	7	63	25,2	SE	Hazy.
	6	1	E	5	29,955	83,0	10	63	25,2	SE	Thick haze.
	7	2	M	5	30,000	80,5	9	64	25,6	W	Cloudy.

for ascertaining the velocity of sound.

119

Table I. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Feet.	Seconds.		
1820. Aug.	7	1	E	6	29.988	81.5	11	64	25.6	SE	Cloudy.
	8	1	M	5	30.015	80.2	9	64	25.6	W	Cloudy.
	19	2	E	6	29.800	88.0	20	61	24.6	W	Hazy.
	20	2	E	6	29.855	85.5	16	63	25.4	SE	Hazy.
	21	1	M	5	29.560	81.0	14	62	24.8	Light land	Clear.
	22	2	E	6	29.935	85.6	18	63	25.2	SE	Clear.
	23	1	E	6	29.965	87.0	19	64	25.6	SE	Hazy; lightning and thunder.
	24	1	M	5	29.956	85.5	18	63	25.4	SE	Hazy.
	25	1	E	6	29.998	83.0	17	64	25.6	Land	Cloudy.
	26	1	E	6	29.945	82.6	14	63	25.2	SW	Cloudy and rain; lightning with [thunder.
	27	2	E	6	29.955	87.5	19	63	25.4	Calm	Hazy.
	28	2	E	6	29.920	88.5	25	64	25.8	E	Hazy.
	29	1	M	5	29.965	82.2	20	63	25.4	Land	Clear.
	30	1	E	6	29.900	85.5	24	64	25.6	NW	Rain.
Sept.	1	2	M	5	29.944	82.8	19	63	25.4	Land	Cloudy and lightning.
	2	1	E	6	29.915	80.5	25	64	25.6	Land	Hazy.
	3	1	E	6	29.957	86.5	20	64	25.6	SE	Clear.
	4	1	E	6	29.925	86.5	19	65	25.2	E breeze	Clear.
	5	1	E	6	29.900	88.2	22	64	25.6	ESE	Hazy.
	6	1	E	6	29.930	86.5	20	63	25.2	Light SE	Hazy.
	7	2	M	5	29.975	81.5	19	63	25.2	Fresh WSW	Cloudy; lightning in the NE quar-
	8	2	E	6	29.935	87.5	18	64	25.6	W by N	Cloudy; lightning to the westward.
	9	2	E	6	29.945	85.2	17	64	25.8	SE by E	Clear; lightning in the SW quarter.
	10	2	M	5	29.970	84.0	15	63	25.4	W by S	Clear.
	11	1	E	6	29.915	85.2	16	63	25.2	SE	Clear; and lightning at a distance.
	12	1	E	6	29.925	84.5	17	65	26.0	SE by E	Hazy.
	13	2	E	6	29.930	86.0	16	63	25.4	SE by S	Hazy.
	14	1	M	5	29.976	83.2	17	63	25.2	SE	Hazy.
	15	2	E	6	29.945	84.5	19	65	26.0	SE	Clear.
	16	1	—	—	29.948	85.5	18	63	25.2	ESE	Clear.
	17	1	—	—	30.100	84.5	16	64	25.6	SE by E	Cloudy.
	18	2	—	—	30.000	82.5	15	65	26.0	NE by E	Cloudy, and some rain.
	19	2	—	—	29.945	80.0	13	63	25.2	SE by S	Cloudy and rain.
	20	2	—	—	29.910	83.0	7	63	25.2	SE by E	Clear.
	21	2	—	—	29.945	83.5	16	64	25.6	ESE	Clear.
	22	1	—	—	30.045	83.5	14	64	25.6	Calm	Cloudy.
	23	1	—	—	30.045	84.5	16	64	25.6	Calm	Clear.
	24	1	—	—	30.015	84.4	14	64	25.6	SE by E	Cloudy.
	25	1	—	—	30.045	86.0	19	64	25.6	SE	Hazy.
	26	2	—	—	29.950	82.5	13	64	25.8	Calm	Cloudy.
	27	2	—	—	29.956	84.8	14	64	25.6	SE by E	Hazy.
	28	2	—	—	30.020	87.0	23	64	25.8	Calm	Hazy.
	29	2	—	—	30.100	88.5	27	64	25.6	Calm	Hazy.
	30	2	—	—	30.055	86.5	21	64	25.6	SE by E	Hazy.
	31	2	—	—	30.005	84.0	15	64	25.8	SE	Hazy.
	32	2	—	—	30.050	87.0	19	64	25.7	SE by S	Clear.
	33	2	—	—	30.065	84.5	19	63	25.4	SW light	Hazy.
	34	2	—	—	30.160	88.5	25	64	25.7	NW	Clear.

MDCCCXXXIII.

Q

Table I. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Beats.	Seconds.		
1820. Sept. Oct.	30	2	E	6	h. Inches.	Dry.					
	1	2	-	-	30,173	89.2	22	64.25	25.7	Calm	Clear.
	2	2	-	-	30,200	89.2	27	64.4	25.8	Calm	Clear.
	3	2	-	-	30,238	91.0	34	64.85	25.9	Calm	Hazy.
	4	2	-	-	30,200	87.8	29	65	26.0	E by N	Thin haze.
	5	1	-	-	30,160	86.6	27	64	25.6	Calm	Hazy.
	6	1	-	-	30,045	86.5	20	64	25.6	SE by S	Hazy.
	7	1	-	-	30,050	86.5	19	64	25.6	SE	Clear.
	8	1	-	-	30,100	86.0	23	64	25.6	SE	Cloudy.
	9	1	-	-	30,088	84.5	22	64.5	25.8	SE	Hazy.
	10	1	-	-	30,088	84.3	20	64.0	25.6	SE	Clear.
	11	1	-	-	30,045	85.8	20	64	25.6	SE	Clear.
	12	1	-	-	30,065	83.5	20	64.5	25.8	SE by S	Clear.
	13	1	-	-	30,045	85.5	21	65.0	26.0	SE by S	Clear; sound indistinct.
	14	1	-	-	30,065	86.2	20	64.5	25.8	NE	Clear.
	15	1	-	-	30,075	86.5	22	66	26.4	E	Clear.
					30,066	86.4	21	66.5	26.6	E	Clear.
										Damp	
	20	1	-	-	30,008	77.5	2	68	27.2	NE	Cloudy.
	21	1	-	-	30,085	81.5	2	67.5	27.0	NE	Clear.
	22	1	-	-	30,055	83.4	0	65.5	26.2	NE by N	Cloudy; distant thunder.
	24	1	-	-	30,078	82.4	2	66.5	26.6	NE	Hazy.
										Dry	
	26	1	-	-	30,110	84.0	14	66	26.4	NE by E	Clear.
	28	2	-	-	30,128	83.2	13	66.5	26.6	NE	Hazy.
										Damp	
Nov.	31	2	-	-	30,082	79.8	3	67.0	26.8	NE light	Cloudy.
	1	2	-	-	30,072	83.0	4	66	26.4	ENE	Hazy.
	2	2	-	-	30,110	84.2	3.5	66.5	26.6	NE	Cloudy.
										Dry	
	3	2	-	-	30,115	84.5	3	67.7	27.1	E	Clear.
	4	2	-	-	30,100	84.5	6	65	26.0	E by S	Clear.
	5	1	-	-	30,135	84.0	11	67	26.8	EN	Clear.
	6	2	-	-	30,140	83.0	15	66	26.4	ESE	Clear.
	7	2	M	5	30,170	77.4	11	65.5	26.2	S by E	Clear.
	8	2	M	5	30,168	83.0	15.5	66.0	26.4	ESE	Clear.
	9	2	M	5	30,188	76.0	12	65.0	26.0	Calm	Clear; sound indistinct.
	10	2	M	5	30,178	83.0	17	65.75	26.3	E by N	Clear.
	11	2	E	6	30,200	83.0	14.5	66.5	26.6	ENE by E	Clear; sound indistinct.
	12	2	E	6	30,178	79.6	11	66.75	26.7	NE	Clear; ditto.
	13	1	-	-	30,175	83.2	11.5	67.0	26.8	NE	Clear.
	14	1	-	-	30,220	83.5	14	66.5	26.6	E by N	Cloudy.
	15	1	-	-	30,134	81.0	1.5	68.5	27.4	NE	Cloudy.
	16	1	-	-	30,125	79.4	2	68.5	27.4	NE	Rather cloudy; sound indistinct.
	17	1	-	-	30,165	83.0	14	66.5	26.6	NE	Hazy.
	18	1	-	-	30,115	79.4	5	67.5	27.0	Light NE	Hazy.
	19	2	-	-	30,125	81.8	5	67.25	26.9	NE	Clear.
	21	2	-	-	30,110	80.5	11	68.25	27.3	NNE	Clear.
	23	1	-	-	30,076	80.0	12	69	27.6	NE	Clear.

for ascertaining the velocity of sound.

115

Table I. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Beats.	Seconds.		
1820.						Inches.	Dry.				
Nov.	24	1	E	6	30,128	80,7	15	68, 5	27,4	NE	Clear; sound very indistinct.
	27	1	-	-	30,135	73,4	14	68	27,2	NE	Clear.
Dec.	4	2	-	-	30,015	75,6	9,5	65,25	26,1	SW by N	Clear.
	5	2	-	-	30,068	79,4	3,0	65, 0	26,0	SE	Clear.
	6	2	-	-	30,075	81,0	6,5	66, 5	26,6	E	Clear.
	7	2	-	-	30,085	80,4	5,5	67,25	26,9	NNE	Clear; sound very indistinct.
	10	2	-	-	30,106	79,3	7,0	68,25	27,3	ENE	Hazy.
	12	2	-	-	30,125	78,8	11,5	68	27,2	N	Cloudy.
	13	1	-	-	30,090	79,0	0,5	67, 5	27,0	NE	Cloudy.
	14	2	M	5	30,074	77,0	1,5	67,25	26,9	NE	Clear.
	15	2	E	6	30,108	81,0	4	67	26,8	E by N	Cloudy.
	16	1	-	-	30,120	81,0	9	67, 5	27,0	NE	Clear.
	17	1	M	5	30,122	77,2	2	66, 5	26,6	NW light	Ditto.
	18	1	E	6	30,112	80,8	7	68, 5	27,4	NE	Ditto.
	19	1	M	5	30,120	77,0	5	68	27,2	NW	Clear and dew.
	19	1	E	6	30,110	79,5	16	67, 5	27,0	NE	Hazy.
	26	2	-	-	30,028	81,6	9	66,25	26,5	NE	Clear.
1821.	27	1	-	-	30,038	81,5	6	67	26,8	ENE	Hazy.
Jan.	8	1	-	-	30,165	76,2	7	68	27,2	NE light	Cloudy.
	9	2	-	-	30,200	79,2	2	68, 5	27,4	NE	Clear.
	10	2	-	-	30,168	79,0	1	67, 0	26,8	NE	Ditto.
	12	2	-	-	30,220	82,0	9	67, 5	27,0	Calm	Ditto.
	16	1	M	5	30,155	76,2	6	66, 5	26,6	Calm	Ditto.
	17	1	E	6	30,155	80,0	8,5	67, 0	26,8	Calm	Hazy.
	17	2	M	5	30,175	75,0	7,5	66, 0	26,4	Calm	Clear.
	19	2	E	6	30,155	80,0	2	68, 5	27,3	East	Cloudy.
	21	1	M	5	30,138	76,5	5,5	67, 0	26,8	NE	Clear.
	22	1	E	6	30,138	79,5	12	67, 5	27,0	E	Ditto.
	22	2	-	-	30,130	80,5	9	66, 5	26,6	NE	Ditto.
	23	2	-	-	30,110	80,6	11,5	66,75	26,7	NE	Ditto.
	24	2	-	-	30,055	80,0	12	66,75	26,7	Calm	Ditto.
	25	2	-	-	30,088	80,5	10	67,75	26,7	Calm	Ditto.
	26	2	-	-	30,100	79,0	10	68, 5	27,4	NE	Cloudy.
	28	1	-	-	30,050	80,5	9,5	67	26,8	Calm	Clear.
	29	1	M	5	30,058	75,2	8,5	66, 5	26,6	Calm	Ditto.
	30	2	E	6	30,048	81,0	9,5	66,25	26,4	Calm	Clear.
	30	1	M	5	30,048	81,0	9,5	66,25	26,5	Calm	Ditto.
Feb.	1	1	M	5	30,000	74,5	8,5	65	26,0	Calm	Hazy; dew
	2	1	E	6	30,062	81,0	13	67, 5	27,0	NE	Clear.
	3	2	-	-	30,105	80,5	13	67	26,8	E	Clear; sound indistinct.
	4	1	-	-	30,148	80,0	12	68	27,2	NE	Ditto.
	5	1	M	5	30,110	76,2	11	68	27,2	NE	Ditto.
	5	1	E	6	30,130	80,6	13	67	26,8	Light NE	Ditto.

Table I. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.	Remarks.
					Barom.	Therm.	Hygrom.	Beats.	Seconds.			
1821. Feb.	6	1	E	6	30,100	78,0	12,5	66, 5	26,6	NE	Clear, sound indistinct.	
	7	1	M	5	30,100	78,0	12,5	66, 5	26,6	Calm	Dicto.	
	8	2	E	6	30,144	80,5	14	66	26,4	Calm	Dicto.	
	9	1	M	5	30,135	79,2	29	64,25	25,7	SE	Dicto.	
	10	1	E	6	30,155	72,5	12	65	26,0	NW	Dicto.	
	11	2	—	—	30,138	80,2	25	65	26,0	SE light	Dicto.	
	12	2	—	—	30,105	79,4	21	63,75	26,3	E	Dicto.	
	13	2	—	—	30,215	77,0	16	65, 5	26,2	Calm	Dicto.	
	14	2	—	—	30,185	80,5	12,5	66,75	26,7	NE	Dicto.	
	15	2	—	—	30,218	80,0	13	67, 0	26,8	Light NE	Dicto.	
	16	2	—	—	30,155	80,5	14	66,25	26,5	E by N	Dicto.	
	17	1	E	6	30,188	80,0	13	66,75	26,7	E	Dicto.	
	18	1	M	5	30,188	75,5	13	66	26,4	Calm	Dicto.	
	19	1	E	6	30,168	79,2	15,6	66	26,4	Light SE	Hazy.	
	20	2	—	—	30,090	79,0	16	66	26,4	Calm	Dicto.	
	21	2	E	6	30,165	73,5	14,5	66	26,4	Calm	Dicto.	
	22	2	—	—	30,100	79,5	14	65, 5	26,2	SE	Dicto.	
	23	2	—	—	30,125	80,3	14	66	26,4	ESE	Dicto.	
	24	2	—	—	30,135	81,0	14	65, 5	26,2	SE	Dicto.	
	25	2	—	—	30,115	70,8	14	66,25	26,5	SE by E	Dicto.	
	26	2	—	—	30,130	81,6	16	65,75	26,3	E by S	Dicto.	
	27	2	—	—	30,120	82,0	16	66	26,4	SE	Dicto.	
	28	2	—	—	30,110	81,6	15	65,75	26,3	SE by E	Dicto.	
March	1	1	—	—	30,100	82,5	14,5	66, 5	26,6	SE	Dicto.	
	2	2	—	—	30,036	83,0	14	65, 5	26,2	SE	Dicto.	
	3	2	E	—	30,015	81,4	14,5	65,25	26,1	SE	Dicto.	
	4	1	—	—	30,060	82,5	14,5	66	26,4	SE	Hazy.	
	5	2	—	—	30,155	82,0	16	65, 5	26,2	SE	Clear.	
	6	2	—	—	30,120	82,0	17	65,25	26,1	SE	Dicto.	
	7	2	—	—	30,045	79,2	20	65, 0	26,0	SE	Dicto.	
	8	2	—	—	30,065	81,5	18,5	65,25	26,1	SE	Dicto.	
	9	2	—	—	30,135	82,0	20	65, 5	26,2	SE	Somewhat hazy.	
	10	2	—	—	30,125	80,8	19	65,75	26,3	SE	Clear.	
	11	1	M	5	30,125	75,5	19	66	26,4	Light SE	Dicto.	
	12	1	—	—	30,110	82,5	19	66	26,4	SE by E	Dicto.	
	13	1	—	—	30,105	80,0	14	66, 5	26,6	SE	Dicto.	
	14	1	—	—	30,110	82,0	13	64, 5	25,8	SE	Cloudy, and rain.	
	15	2	—	—	30,000	82,5	13	65, 0	26,0	SE	Clear.	
	16	2	—	—	30,048	83,0	13,5	65,25	26,1	SE	Dicto.	
	17	1	—	—	30,115	82,5	14	64, 5	25,8	SE	Dicto.	
	18	1	M	5	30,100	80,4	11,5	65	26	SE	Dicto.	
	19	1	M	5	30,125	81,4	14	64	25,6	Light SW	Dicto.	
	20	2	E	6	29,960	82,5	13	64, 5	25,8	SE	Dicto.	
	21	2	—	—	29,948	83,4	12	64, 5	25,8	SE	Dicto.	
	22	1	—	—	30,045	84,0	12	65	26	SE	Cloudy.	
	23	1	—	—	29,975	84,0	12,5	65	26	SE	Clear.	
	24	2	—	—	29,982	83,8	13	64	25,6	SE	Dicto.	
	25	2	—	—	30,000	83,5	13	64,25	25,7	SE	Dicto.	

for ascertaining the velocity of sound.

117

Table I. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Beas.	Seconds.		
1821.											
March	25	2	E	6	h. 30,065	84.5	14.5	64	25.6	SE	Hazy.
	26	1			30,135	83.4	15	65, 5	26.2	Light SE	Ditto.
	28	1			30,105	84.0	16	65, 25	26.1	SE	Clear.
	29	2			30,084	84.0	17.5	66	26.4	ENE	Hazy, and clear.
	30	2			30,110	83.0	16	65, 5	26.2	SE	Clear.
Apr	31	2			30,065	84.5	15.8	65, 5	26.2	SE	Ditto.
	1	2			30,125	84.7	16.3	64.75	25.8	SE	Ditto.
	3	2			30,125	84.0	16	65	26.0	SE	Ditto.
	4	1			30,128	85.0	20	64, 5	25.8	SE	Ditto.
	5	2			30,110	84.5	19	64, 5	25.8	SE	Ditto.
	6	2			30,118	85.0	17	64	25.6	SE	Ditto.
	7	2			30,110	83.5	17	64, 5	25.8	SE	Ditto.
	8	1			30,165	84.5	16.5	64	25.6	SE	Ditto.
	9	2			30,046	84.5	16.5	64, 5	25.8	SE	Ditto.
	10	1			30,028	85.5	19.5	64, 5	25.8	SE	Hazy.
	11	2			29,958	87.5	17	63.75	25.4	SE	Clear.
	12	2			29,955	87.2	18	63.75	25.5	S by E	Ditto.
	13	2			29,965	86.0	16	64, 5	25.8	S	Ditto.
	14	2			30,000	85.0	18	64, 5	25.8	SE	Ditto.
	15	2			30,000	85.0	19	64, 5	25.8	SE	Ditto.
	16	2			30,000	86.5	19	64.75	25.9	SE	Ditto.
	17	2			29,974	85.4	16.4	65.75	26.3	SE	Ditto.
	18	2			29,965	86.0	16	64.25	25.7	SE	Ditto.
	19	2			29,985	86.0	16	63.75	25.5	SE	Ditto.
	20	2			29,988	88.2	16	65, 5	26.2	Fresh SE	Ditto.
May	21	2			30,015	86.5	17	64, 0	25.6	SE	Ditto.
	22	2			30,018	89.8	17.5	64, 5	25.8	SE	Ditto.
	23	2			29,988	86.8	18	63.75	25.5	SSE	Ditto.
	24	2			30,008	86.0	18	64.75	25.9	SE	Ditto.
	25	2			30,015	86.0	16.5	64.75	25.9	SE	Ditto.
	26	1			30,100	87.5	16	65, 5	26.2	SE	Ditto.
	27	2			29,965	86.5	16	65, 25	26.1	SE	Ditto.
	29	2			30,000	83.5	18.5	64.25	25.7	SE	Ditto.
	30	2			30,012	85.0	15.8	65, 25	26.1	SE	Ditto.
	3	1			30,035	85.5	18	64, 0	25.6	SE	Ditto.
	4	2			30,026	87.5	16	64, 5	25.8	SE	Ditto.
	5	2			29,980	87.2	16.2	63, 5	25.4	SSE	Ditto.
	6	1			29,958	87.5	15.5	64, 5	25.8	SE by S	Ditto.
	7	1			29,988	87.2	15	65	26.0	SE	Ditto.
	8	2			29,958	87.0	17.5	64.75	25.9	SE	Ditto.
	9	2			29,958	87.3	15.5	64.25	25.7	SSE	Ditto.
	10	2			29,958	87.0	17	64.25	25.7	SE	Somewhat hazy.
	11	2			29,946	87.4	15.5	64.25	25.7	SE by E	Clear.
	12	2			29,900	87.0	16	64.75	25.9	SE	Hazy.
	13	2			29,855	92.5	17	64.75	25.9	SE by E	Clear.
	14	2			29,858	88.2	15	64.25	25.7	SE	Ditto.
	16	2			29,945	87.2	19	64, 5	25.8	SE	Ditto.
	17	2			29,922	88.0	16.5	64, 5	25.8	SE	Ditto.

Table I. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Rain.	Therm.	Hygrom.	Beats.	Seconds.		
1821.				h.	Inches.	Dry.					
May	18	1	E	6	29.865	87.5	17.5	63.5	25.4	SE	Clear.
	19	2	-	-	29.778	89.2	21.5	64.0	25.6	ESE	Ditto.
	20	3	-	-	29.700	89.2	25	64.25	25.7	ESE	Hazy.
	21	1	-	-	29.788	88.5	26	64.5	25.8	SE	Cloudy.
	22	3	-	-	29.855	88.0	26	64.25	25.7	SSE	Hazy.
	23	1	-	-	29.805	89.2	26	65.0	26.0	SE	Cloudy.
	24	2	-	-	29.788	89.8	25	64.0	25.6	SE	Ditto.
	25	3	-	-	29.815	89.5	26	64.75	25.9	SE	Clear.
	26	2	-	-	29.885	88.0	20.5	64.25	25.7	SSE	Ditto.
	27	3	-	-	29.816	89.0	22.5	64.0	25.6	SE	Ditto.
	28	2	-	-	29.867	86.7	20.0	63	25.2	SE	Ditto.
	29	2	-	-	29.900	89.2	22	62.75	25.1	SE	Ditto.
	30	1	-	-	29.888	87.5	24	63	25.2	SE	Ditto.
	31	2	-	-	29.900	89.2	26	63.25	25.3	S by E	Ditto.
June	1	2	-	-	29.918	87.7	27	64.5	25.8	SE	Ditto.
	2	1	-	-	29.868	88.3	27	63.5	25.4	Fresh SE	Hazy.
	4	2	-	-	29.940	90.7	28	63.75	25.5	SE	Clear.
	5	2	-	-	30.000	86.5	20	63.75	25.5	S	Hazy.
	6	1	-	-	29.965	87.2	22	63	25.0	Fresh S by E	Clear.
	8	1	-	-	29.674	86.0	20	64	25.6	SE	Ditto.
	9	2	-	-	29.900	86.4	18	63.75	25.5	SSE	Ditto.
	10	2	-	-	29.905	87.5	22	64.0	25.6	SE by E	Ditto.
	11	2	-	-	29.858	86.8	19	63.75	25.5	S	Clear; distant lightning.
	12	1	-	-	29.858	87.0	19	65.0	26.0	SE	Clear.
	13	1	-	-	29.845	88.2	22	65.0	26.0	Light SE	Ditto.
	14	2	-	-	29.835	83.5	22	63.5	25.4	SSE	Ditto.
	15	1	-	-	29.865	88.2	22	63	25.2	Fresh SE	Ditto.
	16	1	-	-	29.868	88.5	25	65.5	26.2	Fresh SE	Ditto.
	17	1	-	-	29.855	88.5	22.0	65.5	26.2	Fresh SE	Hazy.
	18	1	-	-	29.900	86.6	23.0	66.0	26.4	Fresh SE	Clear.
	19	2	-	-	29.900	86.0	23.0	63.75	25.5	S	Cloudy.
	20	1	-	-	30.000	86.2	25.5	63	25.2	SE	Clear.
	21	2	-	-	29.945	85.8	25.0	63.75	25.5	Light ESE	Ditto.
	22	2	-	-	29.936	89.0	30.0	63.5	25.4	SE	Cloudy.
	23	2	-	-	29.900	89.6	32	63.75	25.5	Light SE	Ditto.
	25	1	-	-	29.928	87.2	29.5	64.5	25.8	SE by E	Ditto.
	26	2	-	-	29.928	86.5	29.5	64.25	25.7	SE	Ditto.
	27	2	-	-	29.945	85.0	23	63.25	25.3	SSW	Ditto.
	28	2	-	-	29.968	85.2	22	63.25	25.3	SW by S	Clear.
	29	2	M	5	29.988	84.8	27.2	63.25	25.3	NW	Hazy.
	30	2	E	6	29.928	86.2	23	64.0	25.6	SE	Clear.
	31	2	M	5	29.975	86.0	25.8	63.5	25.4	NW	Somewhat hazy.
July	1	2	E	6	29.888	91.0	35	62	24.8	SW	Hazy.
	2	2	M	5	29.925	87.0	34.5	62.75	25.1	W	Clear.
	3	1	E	6	29.838	90.7	37.5	63	25.2	Light W	Hazy.
	4	2	M	5	29.874	88.0	35	63.25	25.3	NW	Cloudy.
	5	2	E	6	29.835	91.6	40	63.25	25.3	Fresh W	Ditto.
	6	2	M	5	29.894	87.0	39.5	64.25	25.7	Light W	Hazy.
	4	1	E	6	29.835	93.5	40	63.0	25.2	SW	Ditto.

for ascertaining the velocity of sound.

119

Table I. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Beats.	Seconds.		
1821. July	4	2	M	5	29.922	89.8	38.5	63.25	25.3	Light NW	Hazy.
	5	2	E	6	29.936	89.5	35.5	63.5	25.4	W	Clear.
	5	2	M	5	29.868	88.5	35.0	63.5	25.4	SE	Flying clouds.
	6	2	E	6	29.878	87.5	32	63.5	25.4	SSE	Cloudy.
	6	2	M	5	29.915	88.7	33	63.5	25.4	WSW	Clear.
	7	2	M	5	29.892	86.4	30	62.75	25.1	SW	Cloudy.
	8	1	E	6	29.908	87.4	31	64	25.6	SE and SW	Ditto.
	8	2	M	5	29.945	86.7	29.5	63.25	25.3	SW	Ditto.
	9	1	E	6	29.885	88.0	34.5	63.5	25.4	Light SW	Hazy.
	9	2	M	5	29.944	86.2	34.7	63.75	25.5	WNW	Ditto.
	10	2	E	6	29.905	88.5	32	62.75	25.1	Light SE	Clear.
	10	2	M	5	29.934	85.8	31.5	62.75	25.1	W by N	Ditto.
	11	2	E	6	29.835	88.5	33.5	65.25	26.1	SE	Cloudy and rain.
	11	2	M	5	29.926	86.5	32.6	63	25.2	Light W	Clear.
	12	2	E	6	29.888	86.5	37	63.75	25.5	SE	Ditto.
	12	2	M	5	29.955	86.5	33	63.5	25.4	Light W	Hazy.
	13	2	E	6	29.928	86.0	35.5	64.0	25.6	SE by E	Cloudy.
	14	2	-	-	29.874	85.0	29.5	64.25	25.7	SE by E	Hazy.
	14	2	M	5	29.873	85.2	29.5	64.0	25.6	Light SW	Ditto.
	15	2	E	6	29.845	86.5	29.8	64.25	25.7	SE	Ditto.
	15	2	M	5	29.900	84.5	27	65.25	26.1	Calm	Cloudy.
	16	2	E	6	29.900	84.5	24	64.25	25.7	SSE	Hazy.
	16	2	M	5	29.915	83.0	23.2	63.0	25.2	SE	Clear.
	17	2	E	6	29.882	86.0	26.7	64.25	25.7	SE	Ditto.
	17	1	M	5	29.924	86.7	24.2	63.5	25.4	Light NW	Ditto.
	18	2	E	6	29.855	88.4	29.5	63.75	25.5	SE	Ditto.
	18	2	M	5	29.810	84.5	25	63	25.2	SW	Cloudy, and some rain. (morning.)
	19	2	E	6	29.900	86.2	24.8	63.25	25.3	Calm	Cloudy, and rain at 4 o'clock in the
	19	2	M	5	29.910	85.0	23.5	64.25	25.7	Calm	Cloudy, and rain in the night.
	20	2	E	6	29.888	86.6	29	64	25.6	SW	Cloudy, and rain.
	20	2	M	5	29.932	84.5	25.6	63	25.2	SW	Hazy.
	21	1	E	6	29.878	87.2	29.5	63	25.2	W by N	Cloudy.
	21	2	M	5	29.942	84.2	29.0	62.75	25.1	Light W	Cloudy, and some rain.
	22	2	E	6	29.858	87.5	31	63.5	25.4	Calm	Hazy.
	23	2	-	-	29.888	88.8	34	62.5	25.0	SW	Ditto.
	23	2	M	5	29.944	86.0	32	63.0	25.2	W	Clear.
	24	2	E	6	29.900	87.2	30	63.75	25.5	SE	Ditto.
	24	2	M	5	29.945	86.6	30	63.25	25.3	W	Ditto.
	25	2	E	6	29.928	87.5	30	64.5	25.8	SE	Ditto.
	25	2	M	5	29.905	86.2	28.5	63.0	25.2	S by W	Hazy.
	26	2	E	6	29.928	87.2	28.5	63.75	25.5	SE	Ditto.
	27	2	-	-	29.945	86.2	25.5	63.5	25.4	SSW	Clear.
	27	2	M	5	29.945	84.2	25.2	64	25.6	Light W	Hazy.
	28	1	E	6	29.905	87.0	31	64	25.6	SW	Clear.
	28	2	M	5	29.945	86.4	28.7	64.75	25.9	NW	Ditto.
	29	2	M	-	29.960	86.0	25.6	64.75	25.9	Calm	Rain.
	30	2	E	6	29.918	87.0	25.5	63.75	25.5	SE	Clear.
	30	2	M	5	29.996	85.0	25.2	64.0	25.6	NW	Hazy; lightning.
	31	2	E	6	29.965	87.8	29.5	64.25	25.7	Light NW	Cloudy.

Table I. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Beats.	Seconds.		
1821.					h.	inches.	Dry.				
July	31	2	M	5	29.990	85.2	26	63.25	25.3	W	Rain.
	1	2	E	6	29.948	83.2	22	63.75	25.5	Light SSW	Hazy.
Aug.	2	2	M	5	29.965	83.0	22	63.25	25.3	SW	Cloudy. [ning to the westward.
	2	2	E	6	29.915	84.8	22	64.25	25.7	Calm	Cloudy; distant thunder and light-
	2	2	M	5	29.925	83.4	22.6	64.25	25.7	SW	Rain.
	3	2	E	6	29.868	87.0	25.5	63.25	25.3	Calm	Hazy.
	3	2	M	5	29.944	80.0	13.5	64.0	25.6	Calm	Somewhat hazy.
	4	1	E	6	29.900	85.2	24	64.0	25.6	W	Cloudy.
	4	2	M	5	29.922	86.2	23.6	63.25	25.3	Light NW	Cloudy; rain the whole night.
	5	2	E	6	29.900	84.8	24	63.0	25.2	W	Misty.
	5	2	M	5	29.985	81.0	23.5	63.25	25.3	SW	Hazy.
	6	2	E	6	29.868	86.0	28.6	62.5	25.0	SW	Cloudy.
	6	2	M	5	29.885	82.0	25	62.75	25.1	SW	Hazy.
	7	2	E	6	29.862	86.2	27.5	62.75	25.1	SW	Cloudy and rain.
	8	2	-	-	29.825	85.6	26.5	62.75	25.1	WNW	Ditto, ditto.
	8	2	M	5	29.860	83.4	27	62.5	25.0	WNW	Ditto.
	9	2	E	6	29.838	83.5	25.5	63.25	25.3	W	Ditto, and rain.
	9	2	M	5	29.875	83.6	25.4	64.25	25.7	Light SW	Hazy.
	10	2	E	6	29.878	88.0	32.0	62.5	25.0	SW	Cloudy.
	10	2	M	5	29.945	85.4	30.0	63.0	25.2	SW	Hazy.
	11	2	E	6	29.878	90.4	35.0	63.0	25.2	SW	Clear.
	11	2	M	5	29.965	86.4	31.8	64.25	25.7	NW	Ditto.
	12	2	E	6	29.925	90.5	35	63.5	25.4	SW by N	Hazy.
	12	2	M	5	29.926	86.0	32.5	63.5	25.4	W	Somewhat hazy.
	13	2	E	6	29.920	90.5	13.0	63.75	25.5	Calm	Cloudy.
	13	2	M	5	29.955	86.5	28.8	62.75	25.1	SW	Ditto.
	14	2	E	6	29.965	87.0	28.5	64.0	25.6	SE	Ditto, lightning.
	15	2	-	-	29.938	88.0	29.5	63.75	25.5	SE	Ditto and some rain.
	15	2	M	5	29.987	84.5	28	64.25	25.7	NW	Clear.
	16	2	E	6	29.908	87.0	28	64.0	25.6	SE	Ditto.
	16	2	M	5	29.940	86.4	28	63.25	25.3	Light SW	Ditto.
	17	2	E	6	29.848	89.8	34	63	25.2	Calm	Ditto.
	17	2	M	5	29.896	86.0	31.7	63.25	25.3	SW	Ditto.
	18	2	E	6	29.835	87.0	33	64.5	25.8	Calm	Ditto.
	18	2	M	5	29.875	85.5	28.4	62.5	25.0	W	Ditto.
	19	2	E	6	29.835	89.5	33.5	63.25	25.3	Calm	Hazy.
	19	2	M	5	29.915	87.0	32	64	25.6	Light W	Cloudy.
	20	2	E	6	29.878	90.6	34.5	62.75	25.1	SW	Ditto.
	20	2	M	5	29.915	86.5	32.5	63.0	25.2	Light W	Hazy.
	21	2	E	6	29.966	86.0	30	63.75	25.5	NW	Ditto.
	21	2	M	5	29.918	90.5	35	63.25	25.3	Calm	Ditto.
	22	2	E	6	29.974	86.0	31.5	63.75	25.5	W	Somewhat hazy.
	23	2	M	5	29.935	92.7	35	63.75	25.5	W	Clear.
	23	2	E	6	29.962	86.6	31.5	64	25.6	NW	Ditto.
	24	2	M	5	29.925	87.5	30	64.5	25.8	SE	Ditto.
	24	2	E	6	29.970	86.0	28	63.0	25.2	SW	Very clear.
	25	1	E	6	29.932	86.7	31.5	63.5	25.4	S	Clear.
	26	2	-	-	29.935	85.6	28	64.5	25.8	SSE	Cloudy.

for ascertaining the velocity of sound.

191

Table I. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Feet.	Seconds.		
1821. Aug.			M	h. Inches.		Dry.					
	27	2	M	5 29.965	84.0	28	63.75	25.5		W	Hazy.
		2	E	5 29.915	87.0	30	64.75	25.9		SE	Very clear.
		2	M	5 29.965	85.0	29.5	63.5	25.4		Light SW	Cloudy.
	28	2	E	5 29.915	86.6	29.0	64.5	25.8		SE	Clear.
		2	M	5 29.968	84.5	26.8	63.5	25.4		SW	Ditto.
	29	2	E	5 29.905	87.5	29.5	64.5	25.8		SE	Ditto.
		1	—	5 29.948	86.5	27	65	26.0		SE	Ditto.
	30	1	M	5 30.016	85.0	25	63	25.2		S	Cloudy, and lightning.
		2	E	5 29.955	85.5	24	65.25	26.1		SE	Clear.
Sep.	31	2	—	5 29.944	85.0	23.5	65	26.0		SE	Ditto.
		2	—	5 29.990	86.0	24	65.5	26.2		E	Cloudy, and thunder.
		2	M	5 30.030	84.2	23.4	63.25	25.3		Fresh SW	Cloudy, and rain in the night.
		2	E	5 29.928	87.0	22.0	63.75	25.5		S	Clear.
	3	2	M	5 9.935	82.4	22	63.0	25.2		SSW	Cloudy, and some rain.
		2	E	5 29.925	86.0	22.5	64.75	25.9		SE	Cloudy.
	4	2	M	5 29.965	82.7	21.5	65.0	26.0		Calm	Thin haze.
		2	E	5 29.945	87.2	25	64.75	25.0		Light SE	Clear.
	5	2	M	5 29.986	83.0	21.5	63.25	25.3		Light SW	Clear, and lightning in the NE.
		2	E	5 29.938	86.2	23	64.75	25.9		SE	Hazy.
	7	2	—	5 29.945	85.4	23	63.75	25.5		SW	Cloudy.
		2	M	5 29.975	84.4	23	63.25	25.3		SW	Hazy.
	8	2	E	5 29.920	85.4	22	63.75	25.5		SE	Ditto.
		2	M	5 29.965	83.0	21.2	63.25	25.3		SW	Rain in the night. [sun rise.
	9	2	M	5 29.932	82.0	22	65.5	26.2		NNW. cold	Cloudy; and rain from sun set to
		2	E	5 29.888	86.0	21	64.25	25.7		Calm	Clear. [loud thunder.
	10	2	M	5 29.915	82.6	19.8	64.75	25.9		Light NW	Rain; lightning, and uncommonly
		2	E	5 29.868	86.0	20.0	64.5	25.8		Calm	Clear.
	11	2	M	5 29.915	80.5	17.4	63	25.2		SW. cold	Cloudy the whole night.
		1	E	5 29.845	84.4	18.2	65.5	26.2		Calm	Hazy.
	12	2	M	5 29.875	82.0	16.7	62.25	24.9		Light SW	Rain, with lightning.
		2	E	5 29.838	83.0	22	65.75	26.3		Calm	Hazy.
	13	2	M	5 29.872	80.5	16	64.75	25.9		Ditto	Cloudy; rain at night.
		2	E	5 29.805	84.2	17	64	25.6		Ditto	Clear.
	15	2	M	5 29.925	82.4	15	64.75	25.9		Ditto	Ditto.
		2	E	5 29.880	84.5	15	64	25.6		Ditto	Hazy.
	16	2	M	5 29.925	83.0	15	63.75	25.5		Ditto	Clear.
		2	E	5 29.878	86.0	17	65.25	26.1		SE	Hazy.
	17	2	M	5 29.945	82.4	17.5	64.75	25.9		NW	Clear.
		2	E	5 29.920	84.6	19	64.75	25.9		SE	Thin haze.
	18	2	M	5 29.948	84.0	16.5	64.25	25.7		Calm	Hazy.
		2	E	5 29.920	85.6	17.5	64.5	25.8		Ditto	Clear.
	19	2	—	5 29.888	84.8	17	65	26.0		SE	Hazy.
	20	2	M	5 29.900	82.4	17	64.25	25.7		NW	Tolerably clear.
		1	E	5 29.835	85.5	19	66	26.4		SW	Cloudy.
	21	2	M	5 29.882	82.6	17.6	64.75	25.9		Calm	Cloudy, with lightning.
		2	E	5 29.945	85.0	19	64.25	25.7		Ditto	
	22	2	—	5 29.858	86.0	23	63.75	25.5		SW	Hazy.
	23	2	M	5 29.884	83.0	27.5	63.25	25.3		W	Mostly cloudy.

MDCCCXXIII.

R

Mr. GOLDINGHAM's experiments

Table I. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Baron.	Therm.	Hygrom.	Beats.	Seconds.		
1821. Sep.	24	2	M	5	Inches.	Dry.					
	24	2	E	5	29.916	84.6	23.5	63.75	25.5	Calm	Clear.
	25	2	E	5	29.878	87.0	28	64.75	25.9	Calm	Cloudy.
	26	2	E	5	29.905	86.2	27	63.75	25.5	SW	Hazy.
	26	2	M	5	29.945	84.5	29.5	63.25	25.3	SW	Cloudy.
	27	2	E	5	29.955	85.6	22	64.75	25.9	SE	Hazy.
	27	2	M	5	30.018	82.7	18	63.75	29.5	Calm & dew	Clear.
	28	2	M	5	29.955	84.4	20	65.75	26.3	Calm	Cloudy; rain and lightning.
	28	2	M	5	30.025	81.6	20	64.25	25.7	Light SW	Cloudy, and lightning.
	29	2	E	5	29.970	83.0	20	64.5	25.8	SW	Cloudy, and rain.
	29	2	M	5	30.034	80.0	18.8	64.0	25.6	Calm	Clear.
	30	2	E	5	30.015	84.2	18.5	64.75	25.9	Ditto	Ditto.
Oct.	30	2	M	5	30.074	81.9	18	63.75	25.5	Ditto	Tolerably clear.
	1	2	E	5	30.038	85.6	20	65	26.0	SE	Clear.
	2	2	M	5	30.082	82.6	17.8	64.25	25.7	Calm	Mostly clear.
	2	2	E	5	30.005	84.5	19	63.75	25.5	Light SE	Clear.
	3	2	E	5	29.945	85.5	18.5	64.25	25.7	SE	Ditto.
	4	2	E	5	29.900	86.2	17.5	64.75	25.9	Ditto	Ditto.
	4	2	M	5	29.975	82.5	16	64.5	25.8	Calm	Clear, and distant lightning.
	5	2	E	5	29.923	85.5	18	64.25	25.7	Ditto	Cloudy.
	5	2	M	5	29.978	79.5	16.8	64.5	25.8	SW	Cloudy, and rain. [thunder.
	6	1	E	5	29.975	85.5	17.5	65.5	26.2	NE	Cloudy; rain, and lightning with
	6	2	M	5	29.985	82.0	17.2	63.25	25.3	W	Hazy, and some rain.
	7	2	E	5	29.965	85.0	16.5	65.25	26.1	NW	Cloudy.
	7	2	M	5	29.990	81.4	16	65.25	26.1	Calm	Cloudy at sun rise.
	8	1	E	5	29.970	85.0	20	65.5	26.2	NE	Hazy.
	8	1	M	5	30.015	83.6	17.2	64.5	25.8	Calm	Clear.
	9	2	E	5	29.978	86.0	21	66.5	26.6	Light NE	Ditto.
	9	2	M	5	29.984	83.0	17.8	65.25	26.1	Calm	Ditto.
	10	2	E	5	29.978	85.0	25	65.5	26.2	Ditto	Ditto.
	10	2	M	5	30.030	83.0	19	64.5	25.8	Ditto	Ditto.
	11	2	E	5	30.005	86.0	27	66.5	26.6	Ditto	Ditto.
	11	2	M	5	30.065	82.0	22	64.75	25.9	Ditto	Very clear.
	12	2	E	5	30.018	86.0	29	67	26.8	E	Ditto.
	12	2	M	5	30.070	79.6	21.5	65.25	26.1	Calm	Ditto.
	13	1	E	5	30.025	86.0	25	66.2	25.4	Ditto	Ditto.
	13	2	M	5	30.080	81.0	21	65.0	26.0	Ditto	Ditto.
	15	2	E	5	30.065	86.7	24	66.25	26.5	E	Ditto.
	16	2	E	5	30.065	87.5	23	66.75	26.7	Ditto	Thin haze.
	17	2	E	5	30.100	83.5	18	67	26.8	NE	Hazy. [afternoon.
	18	2	E	5	30.078	83.0	17	67.5	27.0	NNE	Cloudy; rain at five o'clock in the
	19	1	E	5	30.100	83.0	22	67.5	27.0	Light NE	Clear.
	20	2	E	5	30.043	83.5	27.5	67.5	27.0	NE	Ditto.
	21	1	E	5	30.055	82.5	30	67.5	27.0	Light NE	Ditto.
	22	2	E	5	30.100	79.0	27	67.0	26.8	N	Ditto.
	23	1	E	5	30.070	84.0	25	68.5	27.4	NE	Cloudy
	24	2	E	5	30.025	80.0	10	68.25	27.3	Light NE	Clear.
	25	2	E	5	30.044	84.4	12	65.75	26.3	SE	Ditto.
	26	2	E	5	30.060	81.2	13	67.75	27.1	E	Ditto.

for ascertaining the velocity of sound.

193

Table I. continued.

Month.	Day.	No. of Observations.	Morning & Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Bar.	Seconds.		
1821. Oct. Nov.	27	2	E	6	h. Inches.	Dry.				Light NE	Clear.
	28	2	-	-	30.055	85.0	15.5	67.0	26.8	Ditto.	Clear.
	29	2	-	-	30.035	81.5	1.5	85.5	26.1	Caln	Misty.
	30	1	-	-	30.072	77.0	0.2	66.5	26.6	NE	Clear.
	1	1	-	-	30.113	83.2	3.0	68.5	27.1	NE	Hazy.
	2	1	-	-	30.126	82.3	8	67.5	27.0	NE	Hazy.
	3	1	-	-	30.078	82.0	10.5	68.5	27.2	NE	Clear.
	4	1	-	-	30.075	82.0	13.0	67.5	27.0	NE	Cloudy, and rain.
	5	2	-	-	30.000	81.5	11	67.25	26.9	NE	Clear.
	6	2	-	-	30.100	81.0	9.5	68.25	27.3	NE	Cloudy, and rain.
	7	2	-	-	30.055	81.6	7	68.75	27.5		
Mean					29.992	84.11	19.0		25.869		

TABLE II.

Experiments selected from Table I., the air having been calm.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Weather.
					Barom.	Therm.	Hygrom.	Beats.	Seconds.	
1820.				h.	Inches.	a	Dry.	"		
Aug. Sept.	25	2	E	6	29.955	87.5	19	63, 5	25, 4	Hazy.
	16	2	-	6	30.045	83.5	14	64, 5	25, 6	Cloudy.
	21	2	-	6	29.950	82.5	13	64, 5	25, 8	Cloudy.
	23	2	-	6	30.020	87.0	23	64, 5	25, 8	Hazy.
	24	2	-	6	30.100	88.5	27	64, 0	25, 6	Ditto.
Oct.	30	2	-	6	30.173	89.2	23	64.25	25, 7	Clear.
	1	2	-	6	30.200	89.2	27	64, 4	25, 8	Clear.
	2	2	-	6	30.238	91	34	64.85	25, 9	Hazy.
Nov. 1821.	8	2	M	5	30.188	76	12	65	26, 0	Clear.
Jan.	12	2	E	6	30.220	82	9	67, 5	27, 0	Clear.
	16	2	-	6	30.155	80	8.5	67, 0	26, 8	Hazy.
	1	1	M	5	30.155	76.2	6	66, 5	26, 6	Clear.
Feb.	24	2	E	6	30.055	80.0	12	66.75	26, 70	Clear.
	29	2	-	6	30.048	81.0	9.5	66.25	26, 5	Clear.
	7	2	-	6	30.144	80.5	14	66, 0	26, 4	Clear.
	11	2	-	6	30.215	77.0	16	65, 5	26, 2	Clear.
July	15	2	M	5	29.900	84.5	27	65.25	26, 1	Cloudy.
	19	2	E	6	29.900	86.2	24.8	63.25	25, 3	Cloudy; some rain at 4 o'clock in [the afternoon.
	22	2	M	5	29.910	85.0	23.5	64.24	25, 7	Cloudy; rain in the night.
Aug.	22	2	E	6	29.858	87.5	31	63, 5	25, 4	Hazy.
	29	2	M	5	29.960	86.0	25.6	64.75	25, 9	Rain.
	2	2	E	6	29.915	84.8	22.0	64.25	25, 7	Cloudy.
	3	2	-	6	29.868	87.0	25.5	63.25	25, 3	Hazy.
	2	2	M	5	29.944	80.0	23.5	64, 0	25, 6	Hazy.
	13	2	E	6	29.920	90.5	33.0	63.75	25, 5	Cloudy.
	17	2	-	6	29.848	89.8	34.0	63, 0	25, 2	Clear.
	18	2	-	6	29.835	87.0	33	64, 5	25, 8	Clear.
Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Weather.
					Barom.	Therm.	Hygrom.	Beats.	Seconds.	
1820.				h.	Inches.	a	Dry.	"		
Aug. Sept.	19	2	E	6	29.835	89.5	33.5	63.25	25, 3	Hazy.
	22	2	E	6	29.918	90.5	35.0	63.25	25, 3	Ditto.
	4	2	M	5	29.965	82.7	21.5	65, 0	26, 0	Ditto.
	10	2	E	6	29.888	86.0	21.0	64.25	25, 7	Clear.
	11	2	E	6	29.862	86.0	20.0	64, 5	25, 8	Clear.
	13	2	E	6	29.838	83.0	22.0	65.75	26, 3	Hazy.

for ascertaining the velocity of sound.

125

Table II. continued.

Time.	Day.	Morning or Evening.	Time.	No. of Observations.	Height of			Number of		Weather.
					Barom.	Therm.	Hygom.	Feet.	Seconds.	
1821. Sept.	13	M	5	1	29.872	80.5	16	64.75	25.9	Cloudy; rain at night.
	15	M	5	1	29.865	84.1	17	64.0	25.6	Clear.
	16	M	5	1	29.925	82.4	15	64.75	25.9	Clear.
	16	M	5	1	29.880	84.5	15	64.0	25.6	Hazy.
	18	M	5	1	29.925	83.0	15	63.75	25.5	Clear.
	18	M	5	1	29.948	84.0	16	64.25	25.7	Clear.
	19	E	5	1	29.920	85.6	17	64.5	25.8	Clear.
	21	M	5	1	29.818	82.6	17	64.75	25.9	Cloudy; with lightning
	22	E	5	1	29.945	85.6	19	64.25	25.7	Hazy.
	24	M	5	1	29.916	82.6	23	63.75	25.5	Clear.
	25	E	5	1	29.878	87.0	28	64.75	25.9	Cloudy.
	27	M	5	1	30.018	82.7	18	63.75	25.5	Clear.
	28	E	5	1	29.955	84.4	20	65.75	26.1	Cloudy; rain and lightning.
	29	M	5	1	30.034	80.8	18	64.0	25.6	Clear.
	30	E	5	1	30.015	84.1	18	64.75	25.9	Clear.
Oct.	1	M	5	1	30.074	81.0	18	63.75	25.5	Very clear.
	4	M	5	1	30.082	82.6	17	64.25	25.7	Clear.
	5	M	5	1	29.975	82.5	16	64.5	25.8	Clear, and distant lightning.
	7	M	5	1	29.923	85.5	18	64.25	25.7	Cloudy.
	7	M	5	1	29.990	81.4	16	65.25	26.1	Cloudy at sun rise.
	8	M	5	1	30.015	83.6	17	64.5	25.8	Clear.
	9	M	5	1	29.984	83.0	17	65.25	26.1	Clear.
	10	E	5	1	29.978	85.0	25	65.5	26.2	Clear.
	11	E	5	1	30.030	83.0	19	64.5	25.8	Clear.
	11	M	5	1	30.005	86.0	27	66.5	26.6	Clear.
Nov.	12	M	5	1	30.065	82.0	23	64.75	25.9	Very clear.
	12	M	5	1	30.070	79.6	21	65.25	26.1	Clear.
	13	E	5	1	30.025	86.0	25	66.0	26.4	Clear.
	13	M	5	1	30.080	81.0	21	65.0	26.0	Clear.
	3	E	5	1	30.072	77.0	0	66.5	26.6	Misty.
Mean - -					29.990	83.95	20.31	65.712		

TABLE III.

The wind having been south easterly. Mean of the observations of three days.

Month.	No. of Observations.	Mean height of			Number of		Weather.
		Therm.	Barom.	Hygrom.	Beats.	Seconds.	
		Inches.					
Aug. Sept.	6	85.5	29.915	17.3	63.35	25.34	Hazy.
	6	85.6	29.957	17	63.85	25.54	Hazy.
	6	85.0	29.991	17	64.15	25.66	Hazy.
	6	84.2	29.960	12	63.35	25.34	Mostly clear.
	6	84.2	30.005	14	64	25.6	Mostly cloudy.
Nov.	6	85.8	30.055	18.3	64.25	25.7	Rather hazy.
	6	81.6	30.137	10.7	65.5	26.2	Clear generally.
	6	81.2	30.179	6.2	65.5	26.2	Clear.
Feb.	6	80.2	30.120	14	65.65	26.26	Mostly clear.
	6	78.0	30.118	15	65.9	26.36	Ditto.
	6	82.1	30.050	14.3	65.75	26.3	Ditto.
March	6	81.8	30.113	17.6	65.3	26.12	Alternately clear and cloudy.
	6	81.9	30.103	17.5	65.5	26.2	Clear.
	6	83.0	29.969	12.7	64.4	25.76	Mostly clear.
April	6	83.8	30.092	15.5	64.97	26.0	Clear.
	6	84.4	30.108	16.0	65.1	26.0	Ditto.
	6	84.3	30.113	17.7	64.35	25.7	Ditto.
	6	86.4	30.019	17.2	64.9	25.6	Ditto.
	6	85.3	29.985	17.7	64.5	25.8	Ditto.
May	6	86.3	29.979	17.1	64.95	25.98	Ditto.
	6	86.9	29.996	16.3	64.4	25.76	Ditto.
	6	87.5	30.005	17.8	64.35	25.74	Ditto.
	6	85.3	29.990	17.0	64.75	25.9	Ditto.
	6	86.8	30.006	16.0	64.4	25.76	Ditto.
July	6	87.0	29.958	17.3	64.45	25.78	Somewhat hazy.
	6	89.0	29.900	16.2	64.6	25.82	Clear.
	6	87.8	29.908	16.8	64.45	25.78	Clear.
	6	88.8	29.777	24.2	64.8	25.68	Mostly hazy.
	6	89.1	29.829	23.8	64.8	25.72	Clear.
Aug.	6	88.3	29.876	21.5	63.25	25.30	Clear.
	6	89.5	29.916	27	63.85	25.54	Clear.
	6	86.8	29.902	20	63.85	25.54	Clear.
	6	85.4	29.864	21.3	63.65	25.46	Clear; distant lightning.
	6	88.0	29.927	29	63.7	25.48	Cloudy.
Sept.	6	85.6	29.947	24.8	63.6	25.40	Cloudy.
	6	87.4	29.891	30.0	63.65	25.46	Mostly cloudy.
	6	87.8	29.876	34.2	63.9	25.60	Clear; cloudy and rain.
	6	85.8	29.882	31.6	64.15	25.66	Generally hazy.
	6	86.3	29.879	26.7	64.1	25.64	Clear.
Oct.	6	87.3	29.918	29.5	63.85	25.54	Clear.
	6	87.3	29.941	27.8	63.85	25.54	Clear.
	6	86.7	29.923	28.7	64.35	25.74	Clear.
	6	87.0	29.912	29.5	64.5	25.8	Clear.
	6	85.2	29.972	24	64.25	25.7	Clear.
Oct.	6	86.7	29.933	23.2	64.4	25.76	Clear.
	6	85.8	29.915	20.7	64.55	25.82	Rather hazy.
	6	85.0	29.921	19.0	64.75	25.90	Hazy.
Oct.	6	85.2	29.927	19.2	64.35	25.74	Clear.
	6	85.5	29.972	19.96	25.754		

for ascertaining the velocity of sound.

127

TABLE IV.

The wind having been north easterly. Mean of the observations of three days.

Month.	No. of Observations.	Mean height of			Number of		Weather.
		Therm.	Barom.	Hygrom.	Feet.	Seconds.	
1820.		Inches.		Dry.			
Oct.	6	82	30.094	2	66, 5	26, 6	Mostly hazy.
Nov.	6	83, 9	30.131	5, 6	66, 65	26, 66	Clear and cloudy alternately.
	6	81, 9	30.184	12, 3	66, 75	26, 70	Clear.
	6	81, 5	30.110	4, 8	66, 65	26, 62	Clear.
Dec.	6	80, 9	30.106	4, 2	67, 5	27, 00	Clear.
1821.							
Jan.	6	78, 4	30.103	5, 7	67, 85	27, 14	Mostly cloudy.
	6	80, 6	30.145	2, 7	67, 25	26, 90	Clear and cloudy alternately.
	6	79, 7	30.139	8, 2	67, 06	26, 82	Clear.
Feb.	6	79, 6	30.150	14, 8	67, 55	27, 02	Clear.
	6	80, 3	30.186	13, 2	66, 7	26, 68	Mostly clear.
Oct.	6	84, 0	30.081	21	66, 75	26, 70	Ditto.
	6	85, 9	30.076	21, 7	66, 7	26, 68	Mostly hazy.
	6	83, 2	30.074	22, 2	67, 45	26, 98	Cloudy, and rain.
Nov.	6	82, 7	30.063	9, 3	66, 6	26, 62	Ditto, ditto.
	6	81, 1	30.062	16, 6	67, 65	27, 06	Clear.
Mean		81, 7	30, 113	10, 9		26, 812	

TABLE V.

The wind having been SW. W. and NW. Mean of the observations of three days.

Month.	No. of Observations.	Mean height of			Number of		Weather.
		Therm.	Barom.	Hygrom.	Beats.	Seconds.	
		Inches.	Dry.		"		
Aug.	6	82.9	29.940	11	63, 0	25, 3	Cloudy, and thunder.
Sept.	6	82.2	29.961	19.3	63.35	25, 34	Cloudy, and lightning.
	6	86.7	29.988	19.3	63.92	25, 56	Ditto, ditto.
Dec.	6	85.3	29.973	11.8	63.95	25, 58	Variable.
1821.							
June	6	87.3	29.950	29.3	62, 9	25, 16	Hazy.
July	6	85.5	29.878	16.5	63, 0	25, 20	Mostly cloudy.
	6	88.3	29.917	17.8	63, 7	25, 48	Ditto hazy.
	6	87.3	29.917	30.8	63.15	25, 12	Hazy.
	6	86.2	29.934	32.9	63.20	25, 28	Generally cloudy.
	6	85.2	29.914	28.6	63, 5	25, 4	Clear.
	6	85.9	29.874	26.0	63, 5	25, 4	Hazy.
	6	85.8	29.921	29.5	62.75	25, 1	Ditto.
	6	86.3	29.964	30.0	63, 0	25, 2	Variable.
	6	85.6	29.945	26.5	64, 1	25, 6	Clear.
	6	86.0	29.984	26.9	63.85	25, 54	Hazy; cloudy and lightning.
Aug.	6	83.2	29.981	22.2	61.75	25, 50	Cloudy; distant thunder and lightning with rain.
	6	82.8	29.936	23.7	61.15	25, 26	Cloudy, and rain.
	6	84.7	29.872	27.0	62.65	25, 06	Cloudy, and rain.
	6	84.2	29.841	26.3	62, 8	25, 12	Rain.
	6	85.7	29.899	29.1	63.25	25, 30	Hazy.
	6	89.1	29.923	33.9	63, 6	25, 4	Somewhat hazy,
	6	85.7	29.956	29.8	63, 5	25, 4	Clear.
	6	86.0	29.904	29.4	63, 0	25, 20	Clear, and somewhat hazy.
	6	88.0	29.903	33.0	63.25	25, 30	Clear, and hazy.
	6	88.2	29.958	32.2	61.75	25, 50	Hazy.
	6	85.0	29.966	28.5	63, 4	25, 36	Clear.
Sept.	6	82.7	29.987	24.9	63, 7	25, 48	Rain, and lightning.
	6	83.6	29.955	22.2	63, 3	25, 32	Cloudy, and some rain; thunder and lightning.
	6	82.5	29.937	21.0	64.45	25, 78	Rain from sun set to sun rise.
	6	81.6	29.912	17.2	63, 3	25, 32	Mostly hazy.
	6	84.9	29.888	22.3	63, 9	25, 56	Hazy.
	6	83.0	29.980	23.2	64, 0	25, 60	Mostly cloudy and rain.
Oct.	6	82.2	29.976	16.8	64.35	25, 74	Ditto, ditto.
Mean		85.1	29.934	26		25.374	

TABLE VI.

Experiments for ascertaining the Motion of Sound with a gun placed on the Ramparts of Fort St. George. Station at the top of the Madras Observatory House.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Feet.	Seconds.		
1820. July	16	1	E	h.	Inches.		Dry.				
	16	1	E	8	29.875	82.4	16	31.0	12.4	SE	Cloudy.
	17	1	—	8	29.830	83.2	14	31	12.4	SE	Hazy.
	18	1	M	5	29.845	79.8	10	33	13.2	NW	Cloudy.
	18	1	E	8	29.848	81.9	10	31	12.4	Light SE	Clear.
	19	1	M	5	29.870	79.8	12	32	12.8	Light NE	Cloudy, and rain.
	19	1	E	8	29.875	82.5	13	30	12.0	SE	Clear.
	20	1	E	8	29.878	83.0	14	30	12.0	SE	Ditto.
	21	1	E	8	29.900	82.0	14	31	12.4	SE	Cloudy.
	22	1	M	5	29.920	80.0	12	31	12.4	W	Ditto.
	22	1	E	8	29.925	80.4	15	30	12.0	Calm	Ditto.
	23	1	M	5	29.920	80.5	14	31	12.4	Land or W	Ditto.
	23	1	E	8	29.926	82.0	15	31	12.4	Calm	Ditto.
	24	1	M	5	29.920	80.0	14	31	12.4	W	Hazy.
	24	1	E	8	30.000	82.8	15	30	12.0	SE	Rain.
	25	1	M	5	29.955	80.2	14	32	12.8	Land	Cloudy.
	25	1	E	8	29.988	84.0	19	31	12.4	SE	Ditto.
	26	1	M	5	30.045	80.0	16	31	12.4	Light land	Hazy.
	26	1	E	8	30.040	85.0	20	31	12.4	W	Cloudy.
	27	1	M	5	30.050	82.2	20	30	12.0	W	Hazy.
	27	1	E	8	30.055	83.0	19	30	12	SE	Thin haze.
	28	1	M	5	30.055	80.7	15	31	12.4	W	Cloudy.
	28	1	E	8	30.025	81.0	9	30	12.0	Calm	Ditto.
	29	1	M	5	30.020	79.8	9	32	12.8	SE	Variable.
	29	1	E	8	30.022	79.8	7	31	12.4	SE	Cloudy.
	30	1	M	5	30.040	77.8	7	30	12.0	W	Clear.
	30	1	E	8	30.008	83.0	7	29	11.6	Fresh SE	Very clear.
	31	1	M	5	30.025	81.0	8	30	12.0	Light SW	Clear.
	31	1	E	8	30.000	81.7	10	30	12.0	SSE	Cloudy.
Aug.	1	1	E	8	30.015	82.0	7	30	12.0	Light SE	Clear.
	2	1	E	8	30.000	81.0	5	30	12.0	Calm	Cloudy.
	3	1	M	5	30.020	80.2	4	30	12.0	W	Ditto.
	3	1	E	8	30.025	82.5	6	29	11.6	SE	Clear.
	4	1	—	8	30.015	81.5	8	30	12.0	SE	Ditto.
	5	1	M	5	30.030	80.0	7	29	11.6	Calm	Cloudy.
	5	1	E	8	29.975	82.0	7	29	11.6	SE	Clear.
	6	1	—	8	29.965	82.5	6	31	12.4	SW	Cloudy.
	7	1	M	5	30.000	80.5	9	30	12.0	Land	Ditto.
	7	1	E	8	30.015	81.0	8	30	12.0	Calm	Ditto.
	8	2	E	5	30.015	80.2	9	31.5	12.6	W	Ditto.
	8	2	E	8	29.945	81.0	10	31	12.4	W	Cloudy, and lightning.
	9	1	M	5	29.955	79.8	9	32	12.8	W	Cloudy.
	9	2	E	8	29.955	82.0	10	32	12.8	Fresh W	Cloudy, and thunder.
	11	2	M	5	30.000	80.6	8	30.5	12.2	Light SW	Hazy.
	11	2	E	8	29.965	84.0	9	30.0	12.0	SE	Ditto, and lightning.
	12	2	M	5	29.978	81.2	5	31.0	12.4	W	Clear, and distant lightning.
	12	2	E	8	29.945	83.3	8	30.0	12.0	SE	Hazy, and distant lightning.
	13	2	M	5	30.000	81.4	7	30.5	12.2	Calm	Cloudy, and ditto.

Table VI. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.	
					Barom.	Therm.	Hygrom.	Beats.	Seconds.			
					Inches. <td>°<td>Dry.<td></td><td></td><td></td><td></td></td></td>	° <td>Dry.<td></td><td></td><td></td><td></td></td>	Dry. <td></td> <td></td> <td></td> <td></td>					
1830. Aug.	13	2	E	8	29.955	84.4	11	31.0	12.4	Light SW	Hazy.	
	14	2	M	5	29.970	81.5	11	31.0	12.4	Ditto	Cloudy, and lightning.	
	15	2	E	8	29.950	84.0	11	29.5	11.8	Calm	Ditto.	
	16	2	E	8	29.920	83	9	31.0	12.4	W	Hazy.	
	17	2	E	8	29.865	84.5	17	30.0	12.0	SE	Cloudy.	
	18	2	E	8	29.855	85.0	20	31.5	12.6	Land	Ditto.	
	19	2	E	8	29.845	86.0	19	31	12.4	SW	Ditto.	
	20	2	—	8	29.800	87.2	21	31	12.4	SW	Ditto.	
	21	2	E	8	29.900	85.0	14	30.5	12.2	SE	Clear.	
	22	2	M	5	29.960	83.0	14	31.0	12.4	W	Ditto.	
	23	2	E	8	29.915	84.4	14	31.0	12.4	Fresh SE	Ditto.	
	24	1	M	5	29.910	82.5	13	30.0	12.0	NW	Cloudy, and thunder to the east-	
	25	2	E	8	29.998	83.0	15	30.0	12.0	Land	Cloudy.	
	26	2	E	8	29.965	85.5	17	30.5	12.2	SE	Ditto.	
	27	2	—	8	30.005	84.0	17	30.5	12.2	SE	Clear.	
	28	1	M	5	29.932	86.2	19	30.5	12.2	SE	Ditto.	
	29	2	E	8	29.965	82.2	20	31.0	12.2	W	Ditto.	
	30	2	M	5	29.910	84.5	24	30.5	12.2	Light SE	Ditto.	
	31	2	E	8	29.944	82.8	19	31	12.4	Land	Cloudy, and distant lightning.	
	Sept.	1	2	E	8	29.935	85.2	19	29.5	11.8	SE	Clear.
		2	2	E	8	29.965	84.5	19	29.5	11.8	SE	Ditto.
		3	2	E	8	29.935	83.5	17	31	12.4	ESE	Ditto.
		4	2	E	8	29.925	84.0	19	29.5	11.8	SE by E	Ditto.
		5	2	E	8	29.960	85.2	19	30.5	12.2	SE by E	Cloudy.
		6	2	M	5	29.975	81.5	19	32.0	12.8	WSW	Ditto.
		7	2	E	8	29.965	82.2	19	30.5	12.2	Light SW	Clear, and distant lightning.
		8	2	E	8	29.940	84.0	17	30.0	12.0	SE by S	Clear, ditto.
		9	2	M	5	29.970	84.0	15	32.0	12.8	W by S	Clear.
		10	2	E	8	29.965	84.0	15	30.5	12.2	SE by S	Clear, and distant lightning.
		11	2	E	8	29.970	82.6	19	31.0	12.4	Calm	Thin haze.
		12	2	E	8	29.965	84.4	15	30.0	12.0	SE	Haze.
13		2	M	5	29.976	83.2	17	31.0	12.4	W by S	Hazy, and lightning.	
14		2	E	8	29.970	84.0	15	30.5	12.2	SE by S	Vivid lightning and thunder.	
15		2	E	8	30.000	83.5	18	30.0	12.0	SE by S	Clear.	
16		2	E	8	29.975	84.2	17	30.0	12.0	SSE	Clear, and vivid lightning and thun-	
17		2	E	8	29.975	84.5	14	31.0	12.4	Light NE	Lightning, ditto, ditto.	
18		2	E	8	29.930	79.5	12	31.0	12.4	SE	Flying clouds.	
19		2	E	8	29.915	81.5	7	30.5	12.2	SE	Ditto.	
20		2	E	8	29.960	83.2	14	30.5	12.2	SE	Ditto.	
21		2	E	8	29.948	83.0	13	30.5	12.2	Light SE	Ditto.	
22		2	E	8	30.045	81.5	13	30.5	12.2	SE by E	Haze.	
23		1	E	8	30.010	83.0	13	31.0	12.4	Calm	Hazy.	
24		2	E	8	30.020	84.5	15	31.5	12.6	SE by E	Cloudy.	
25		2	E	8	30.020	82.0	15	31.0	12.4	Calm	Ditto.	
26		2	E	8	29.950	82.0	11	31.0	12.4	W by N	Ditto.	
27		2	E	8	29.958	81.5	14	31.0	12.4	SE by E	Hazy.	
28		2	E	8	30.050	86.6	21	30.5	12.2	Calm	Ditto.	
29		2	E	8	30.088	85.5	26	30.5	12.2	Ditto	Clear.	
30		2	E	8	30.045	85.0	20	30.5	12.2	SE	Ditto.	
31		2	E	8	30.000	81.5	18	31.0	12.4	SE by E	Flying clouds.	
1	2	—	—	30.062	85.0	15	30.5	12.2	SE	Clear; some lightning.		
2	1	—	—	30.070	81.2	17	32.0	12.8	SW	Flying clouds; lightning.		
3	1	—	—	30.166	88.2	24	31.0	12.4	NW	Clear; lightning to the south.		

for ascertaining the velocity of sound.

131

Table VI. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Beats.	Seconds.		
1830. Sept. Oct.	30	2	E	h.	Inches.	Dry.					
	1	1	-	-	30,200	87.0	21	31, 3	12, 3	Calm.	Clear; lightning to SW. quarter.
	2	1	-	-	30,210	86.5	22	30, 3	12, 12	Ditto.	Ditto; ditto to the north.
	3	1	-	-	30,230	87.2	26	30, 7	12, 28	Ditto.	Ditto.
	4	1	-	-	30,200	85.2	27	30, 5	12, 2	Ditto.	Ditto.
	5	1	-	-	30,145	85.2	23	30, 5	12, 2	SE	Hazy.
	6	1	-	-	30,040	84.8	19	30, 0	12, 0	Ditto.	Clear.
	7	1	-	-	30,050	86.4	18	30, 0	12, 0	SE by E	Flying clouds.
	8	1	-	-	30,088	85.4	20	29, 5	11, 8	SE	Cloudy.
	9	1	-	-	30,100	85.5	21	30, 0	12, 0	Ditto.	Clear.
	10	1	-	-	30,075	83.5	19	30, 0	12, 0	Ditto.	Ditto.
	11	1	-	-	30,075	83.5	20	30, 5	12, 2	Ditto.	Ditto.
	12	1	-	-	30,075	83.2	19	30, 0	12, 0	Ditto.	Ditto.
	13	1	-	-	30,038	83.5	21	30	12, 0	Ditto.	Ditto; lightning to the north.
	14	1	-	-	30,055	84.5	20, 5	30	12	NE by E	Ditto.
	15	1	-	-	30,082	84.0	21	30, 5	12, 2	NE	Ditto.
	16	1	-	-	30,120	85.2	21	31, 5	12, 6	E by S	Ditto.
	17	1	-	-	30,124	84.4	20, 5	31, 0	12, 4	Light NE	Rather hazy.
	18	1	-	-	30,038	81.0	15, 5	30, 5	12, 2	NE by N	Cloudy.
	19	1	-	-	30,050	77.0	6	31, 5	12, 6	NE	Rain.
Nov.	20	1	-	-	30,138	77.0	2	31, 0	12, 4	N	Hazy.
	21	1	-	-	30,080	80.0	3	30, 5	12, 2	NE by N	Clear.
	22	1	-	-	30,065	81.0	1, 5	32, 0	12, 8	NNW	Cloudy; thunder and lightning.
	23	1	-	-	30,088	80.0	1, 5	31, 0	12, 4	Calm.	Clear.
	24	1	-	-						Dry.	
	25	1	-	-	30,112	80.8	7, 5	31, 5	12, 6	Ditto.	Ditto.
	26	1	-	-	30,120	78.5	11	32, 0	12, 8	Ditto.	Ditto.
	27	2	-	-	30,135	80.2	13, 5	31, 25	12, 5	NE light	Ditto.
	28	1	-	-	30,135	82.0	11, 5	31, 0	12, 4	NE	Cloudy.
	29	2	-	-	30,124	81.5	11, 5	30, 75	12, 3	NNE	Ditto.
	30	1	-	-						Damp	
	31	2	-	-	30,085	79.0	4	31	12, 4	NW	Hazy and clear.
	1	1	-	-	30,118	82.0	4	30, 5	12, 2	Calm.	Clear; distant lightning in the SW.
	2	1	-	-						Dry.	
	3	1	-	-	30,125	82.5	4	30, 7	12, 28	Ditto.	Ditto.
	4	1	-	-	30,110	81.3	6	31, 5	12, 6	Ditto.	Ditto.
	5	1	-	-	30,128	82.0	10	31, 0	12, 4	ENE	Ditto.
	6	1	-	-	30,145	80.4	15	30, 5	12, 2	E	Ditto.
	7	1	M	5	30,170	77.4	11	31, 0	12, 4	S by E light	Ditto.
	8	2	M	5	30,172	79.0	15	30, 75	12, 3	Calm.	Ditto.
	9	2	M	5	30,188	76.0	12	30, 0	12, 0	Ditto.	Ditto.
	10	2	M	5	30,186	80.4	16	30, 25	12, 1	Ditto.	Ditto.
	11	2	M	5	30,188	80.8	12, 5	31, 25	12, 5	NNW	Ditto.
	12	2	M	5	30,188	80.4	13	30, 5	12, 2	NNE	Ditto.
	13	2	M	5	30,178	79.0	11	30, 5	12, 2	NE	Ditto.
	14	2	M	5	30,178	82.0	11, 5	30, 5	12, 2	Ditto.	Ditto.
	15	2	M	5	30,205	81.5	12, 5	30, 75	12, 3	E by N	Cloudy.
	16	2	M	5	30,165	78.4	8	30, 75	12, 3	NE	Ditto.
	17	2	M	5	30,165	78.4	1, 5	30, 5	12, 2	Ditto.	Clear.
	18	2	M	5	30,130	79.2	3	30, 0	12, 0	Ditto.	Cloudy.
	19	2	M	5	30,130	82.0	6	30, 0	12, 0	Ditto.	Clear.
	20	2	M	5	30,170	81.0	15	30, 5	12, 2	ENE	Rather hazy.
	21	2	M	5	30,120	80.0	5	30, 0	12, 0	NE	Cloudy.

Table VI. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Feet.	Seconds.		
1820. Nov.	19	2	E	8	h. 30,110	79.5	Dry.	30,75	12.3	NE	Clear.
	20	1	-	-	30,120	78.0	4	30,75	12.3	ENE	Cloudy.
	21	1	-	-	30,085	78.5	9.5	30,25	12.1	NNE	Clear.
	22	1	-	-	30,075	80.0	9	30,75	12.3	NE	Ditto.
	23	1	-	-	30,110	78.5	12	30,75	12.3	Ditto	Ditto.
	24	1	-	-	30,145	78.8	13	30,75	12.3	Ditto	Ditto.
	25	1	-	-	30,110	78.5	10.5	31, 0	12.4	NE by N	Ditto.
	27	1	-	-	30,180	79.0	14	31, 0	12.4	ENE	Ditto.
	28	1	-	-	30,188	78.0	15	32	12.8	NE	Ditto.
	29	2	-	-	30,210	78.0	19	31.25	12.5	Ditto	Cloudy.
							Damp				
	4	-	-	-	30,030	75.2	9	31, 5	12.6	NNW	Clear.
	5	-	-	-	30,100	77.2	4	31, 0	12.4	Calm	Ditto.
	6	-	-	-	30,088	78.5	5.5	36, 5	12.2	ENE	Clear.
	7	-	-	-	30,110	78.0	3	31, 0	12.4	NE	Ditto.
							Dry.				
	8	-	-	-	30,160	77.8	6	30,75	12.3	NNE	Ditto.
	10	-	-	-	30,120	77.4	8	31, 0	12.4	NE	Ditto.
			M	5	30,115	76.0	4	31.25	12.5	N	Ditto.
	11	-	E	5	30,115	76.0	12	31.25	12.5	NNE	Ditto.
	12	-	M	5	30,078	75.0	5	31.25	12.5	NbW light	Hazy.
			E	5	30,135	78.0	10	30, 5	12.2	NE	Cloudy.
							Damp				
Dec.	14	1	M	5	30,074	77.0	1.5	31, 0	12.4	Ditto	Clear.
							Dry.				
	2	E	8	5	30,100	79.0	2	30.25	12.1	E	Ditto.
	15	2	-	-	30,110	79.5	4.5	30, 5	12.2	Ditto	Ditto.
	16	1	M	5	30,095	78.0	1.0	30	12.0	E by E	Cloudy.
	3	E	8	5	30,125	79.5	8.5	31, 0	12.4	ENE	Clear.
	17	1	M	5	30,122	77.2	2.	30, 5	12.2	NW light	Ditto.
	3	E	8	5	30,135	79.2	6.5	30,75	12.3	NE	Ditto.
	18	1	M	5	30,135	75.0	5	31, 0	12.4	NNE	Ditto.
	19	-	-	-	30,120	77.0	5	30, 5	12.2	NW	Clear and dew.
			E	8	30,115	78.5	15	30, 0	12.0	E by N	Hazy.
	20	-	-	-	30,045	76.7	7	31, 5	12.6	NE	Cloudy.
							Damp				
	24	-	-	-	30,120	80.0	1	30, 0	12.0	Ditto	Clear.
	25	2	-	-	30,048	78.2	12	31, 0	12.4	Ditto	Ditto.
	26	1	-	-	30,058	84.5	9	30, 5	12.2	E	Ditto.
	27	2	-	-	30,075	79.2	6	31, 0	12.4	ENE	Hazy.
							Dry.				
	28	2	-	-	30,075	78.5	2.5	30,75	12.3	Ditto	Clear.
	29	1	-	-	30,110	79.2	5	31, 0	12.4	NE	Haze.
	30	2	-	-	30,100	79.0	9.5	31.25	12.5	Ditto	Cloudy.
							Damp				
1821. Jan.	3	2	-	-	30,028	75.5	4	31, 5	12.6	Ditto	Clear.
	4	1	M	5	30,032	74.0	6	32, 0	12.8	Ditto	Ditto.
			E	8	30,065	75.5	0.5	31, 0	12.4	Ditto	Ditto.
	5	-	M	5	30,100	76.0	4	31, 5	12.6	Ditto	Hazy.
			E	8	30,128	77.2	3	30, 5	12.2	Ditto	Clear.
	6	2	-	-	30,138	75.5	3.5	31.25	12.5	Ditto	Ditto.
	7	-	-	-	30,150	77.2	7	31.25	12.5	Ditto	Cloudy.
	8	-	-	-	30,166	76.5	7	31	12.4	NE	Clear.

Table VI. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hypsom.	Feet.	Seconds.		
1820. Jan.	9	2	E	8	30,205	77.5	Damp	31	12.4	Calm	Clear.
	10	1	M	5	30,206	75.2		31, 5	12.6	Ditto	Ditto.
			E	8	30,188	77.2		30, 75	12.3	Ditto	Ditto.
	11	1	M	5	30,200	74.6		31, 5	12.6	NW light	Ditto.
			E	8	30,218	75.8		31	12.4	NNE	Ditto.
	13	1	-	-	30,300	77.2		31	12.4	ENE	Ditto.
	14	2	-	-	30,300	77.5		31	12.4	Calm	Hazy.
	15	-	-	-	30,165	78.2		31, 25	12.5	Light NE	Clear.
	16	1	M	5	30,155	76.2		30, 5	12.3	Calm	Ditto.
			E	8	30,160	77.5		30, 75	12.3	Ditto	Ditto.
	17	-	-	-	30,175	77.2		30, 75	12.3	East	Ditto.
	18	1	M	5	30,200	76.5		30, 5	12.3	Calm	Ditto, and dew.
	19	2	E	8	30,156	79.2		31, 75	12.7	Ditto	Cloudy.
	20	-	-	-	30,130	79.0		31	12.4	East	Ditto.
	21	1	M	5	30,139	76.5		31	12.4	NE	Clear.
			E	8	30,138	77.5		31, 25	12.5	NE light	Ditto.
	22	2	-	-	30,118	78.0		31, 0	12.4	Ditto	Ditto.
	23	-	-	-	30,120	78.5		30, 5	12.3	NE	Ditto.
	24	2	-	-	30,080	78.5		31, 0	12.4	Calm	Ditto.
	25	1	-	-	30,100	79.2		31, 0	12.4	NE	Hazy.
			M	5	30,132	77.0		31, 0	12.4	E	Clear, and dew.
	26	2	E	8	30,118	79.0		31, 0	12.4	NE	Hazy.
	27	1	M	5	30,115	76.5		30, 5	12.2	Calm	Flying clouds.
			E	8	30,115	78.2		31, 5	12.6	NE	Hazy.
	28	1	-	-	30,050	80.5		30, 0	12.0	Ditto	Clear.
	29	-	-	-	30,050	77.8		30, 5	12.2	SE light	Ditto.
	30	2	-	-	30,035	77.8		31, 25	12.5	Calm	Ditto.
	31	-	-	-	30,005	77.8		30, 5	12.2	SE	Hazy.
Feb.	1	1	M	5	29,998	74.5		32	12.8	Calm	Ditto.
			E	8	30,020	77.5		30	12.0	E by S	Clear.
	2	-	-	-	30,028	77.2		30, 75	12.3	NNE	Hazy.
	3	-	-	-	30,105	80.5		30, 75	12.3	E	Clear.
	4	-	-	-	30,168	78.0		31, 25	12.5	NE	Ditto.
							Damp				
	5	1	M	5	30,110	76.2		31, 5	12.6	Light NE	Clear.
			E	8	30,125	77.5		30, 5	12.2	East	Ditto.
	6	2	-	-	30,125	76.0		32	12.2	Calm	Ditto.
			M	5	30,100	74.0		34, 5	12.6	Ditto	Ditto.
	7	2	E	8	30,148	75.5		31, 25	12.5	Ditto	Ditto.
			M	5	30,135	73.0		30, 5	12.2	Ditto	Ditto.
	8	2	E	8	30,145	74.5		30, 75	12.3	Ditto	Ditto.
			M	5	30,155	72.5		31, 0	12.4	NW	Ditto.
	9	2	E	8	30,145	73.5		31, 0	12.4	Calm	Ditto.
	10	2	-	-	30,200	76.0		31, 0	12.4	Ditto	Ditto.
	11	-	-	-	30,300	80.0		31, 0	12.4	Light E	Ditto.
	12	-	-	-	30,215	77.0		30, 75	12.3	NE	Ditto.
	13	-	-	-	30,192	78.2		31, 25	12.5	ENE	Ditto.
			M	5	30,210	76.0		30, 0	12.0	NW	Thin haze.
	14	1	E	8	30,165	78.2		30, 5	12.2	NE	Clear.
	15	2	-	-	30,184	78.6		31, 25	12.5	Calm	Ditto.
			-	-	30,188	78.0		31, 0	12.4	Ditto	Ditto.
	16	1	M	5	30,188	75.5		31, 0	12.4	Ditto	Ditto.

Table VI. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Wind.	Weather.
					Barom.	Therm.	Hygrom.	Barom.	Seconds.		
1830.					Inches.	Damp					
Feb.	17	2	E	8	30.182	76.0	14.0	31.75	12.7	Calm	Clear.
	18	1	M	1	30.092	77.8	15.0	30.75	12.3	Ditto	Ditto.
	19	2	E	1	30.165	73.5	14.5	31.0	12.4	Ditto	Ditto.
	20	1	E	1	30.085	78.2	14.5	31.25	12.5	SE	Ditto.
	21	1	E	1	30.135	77.8	13.5	30.75	12.3	Light SE	Ditto.
	22	1	E	1	30.144	79.2	14.0	30.75	12.3	SE	Ditto.
	23	1	E	1	30.118	79.5	14.5	31.5	12.6	SE by E	Ditto.
	24	1	E	1	30.118	79.5	16.5	31.25	12.5	E by S	Ditto.
	25	1	E	1	30.125	80.4	16.5	30.5	12.2	SE	Ditto.
	26	1	E	1	30.115	80.5	15.5	31.0	12.4	SE by E	Ditto.
March	27	1	E	1	30.120	81.2	14.0	31.25	12.5	SE	Ditto.
	28	2	E	1	30.040	85.5	14.0	30.5	12.2	Ditto	Ditto.
	29	2	E	1	30.035	81.2	14.0	31.0	12.4	Ditto	Ditto.
	30	1	E	1	30.068	81.5	14.5	31.25	12.5	Ditto	Ditto.
	31	1	E	1	30.125	81.5	15.5	30.5	12.2	Calm	Ditto.
	1	1	E	1	30.11	79.2	17.5	30.5	12.2	Ditto	Ditto.
	2	1	E	1							
	3	1	E	1							
	4	1	E	1	30.048	79.2	19.0	30.75	12.3	SE.	Ditto.
	5	1	E	1	30.078	80.2	18.0	30.75	12.3	Ditto	Ditto.
	6	1	E	1	30.140	79.5	20.0	31.0	12.4	Ditto	Ditto.
	7	1	E	1	30.125	80.8	19.0	30.5	12.2	Ditto	Ditto.
	8	2	M	8	30.125	75.5	19.0	31.0	12.4	Ditto	Ditto.
	9	2	E	8	30.115	81.5	18.5	31.5	12.6	Ditto	Ditto.
	10	1	E	1	30.124	81.0	14.0	31.0	12.4	Calm	Cloudy; lightning.
	11	1	E	1	30.085	80.5	10.0	30.75	12.3	Light SE	Cloudy.
	12	1	E	1	30.025	82.0	12.0	31.0	12.4	SE.	Clear.
	13	1	E	1	30.018	82.0	12.0	30.5	12.2	SE	Ditto.
	14	1	E	1	30.058	82.0	12.0	30.25	12.1	SE	Ditto.
	15	1	E	1	30.120	83.0	14.0	31.5	12.6	SSW	Ditto.
	16	1	M	8	30.100	81.4	11.5	31.0	12.4	SE.	Ditto.
	17	2	E	8	30.110	83.4	14.0	30.75	12.3	SE	Ditto.
	18	2	E	8	30.125	81.4	14.0	31.0	12.4	Light SW	Ditto.
	19	2	E	8	29.998	81.5	12.0	31.0	12.4	SE.	Clear, and haze.
	20	1	E	1	29.988	81.0	11.0	30.75	12.3	SE by E	Cloudy.
	21	1	E	1	29.968	83.5	12.0	31.5	12.6	S.	Ditto.
	22	1	E	1	30.015	82.8	11.0	31.0	12.4	SE.	Clear.
	23	1	E	1	29.980	83.0	11.0	31.0	12.4	Ditto	Ditto.
	24	2	E	1	30.015	83.0	12.5	30.5	12.2	Ditto	Ditto.
	25	2	E	1	30.015	83.0	12.5	30.75	12.3	Ditto	Ditto.
	26	1	E	1	30.100	83.5	14.0	30.75	12.3	Light ditto	Ditto.
	27	1	E	1	30.138	82.4	15.0	30.5	12.2	Ditto	Ditto.
	28	1	E	1	30.085	83.0	18.0	30.0	12.0	Calm	Cloudy.
	29	1	E	1	30.085	83.0	18.0	30.0	12.0	SE	Clear.
Mean					30.065	80.47	11.36	30.75	12.306		

for ascertaining the velocity of sound.

186

TABLE VII.

Experiments selected from Table VI. the air having been calm.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Barom.	Therm.	Hygrom.	Beauf.	Scale.	Wind.	Weather.	Dist.	Remarks.
					Barom.	Therm.	Hygrom.	Beauf.	Scale.									
1820. July.	22	1	E	8	30.025	80.4	15	30	12.0	30.025	80.4	15	30	12.0	Cloudy.	M	1	81
	23	1	-	-	30.026	81.0	15	31	12.4	30.026	81.0	15	31	12.4	Ditto.	M	1	81
	28	1	-	-	30.045	81.0	15	30	12.0	30.045	81.0	15	30	12.0	Ditto.	M	1	81
Aug.	2	1	-	-	30.000	81.0	15	30	12.0	30.000	81.0	15	30	12.0	Ditto.	M	1	81
	5	1	M	5	30.030	80.0	7	49	11.6	30.030	80.0	7	49	11.6	Ditto.	M	1	81
	7	1	E	8	30.015	81.0	15	30	12.0	30.015	81.0	15	30	12.0	Ditto.	M	1	81
Sept.	13	2	M	5	30.000	81.4	7	49	5.12.0	30.000	81.4	7	49	5.12.0	Ditto.	M	1	81
	14	2	E	8	29.950	84.0	11	49	5.11.0	29.950	84.0	11	49	5.11.0	Ditto.	M	1	81
	6	2	-	-	29.970	83.0	19	31	0.12.4	29.970	83.0	19	31	0.12.4	Thin haze.	M	1	81
Oct.	18	1	-	-	30.010	83.0	11	31	0.12.4	30.010	83.0	11	31	0.12.4	Clear.	M	1	81
	20	2	-	-	30.020	82.0	15	31	0.12.4	30.020	82.0	15	31	0.12.4	Cloudy.	M	1	81
	23	2	-	-	30.050	86.0	21	30	5.12.2	30.050	86.0	21	30	5.12.2	Thick haze.	M	1	81
Nov.	24	2	-	-	30.088	85.5	20	30	5.12.2	30.088	85.5	20	30	5.12.2	Clear.	M	1	81
	30	1	-	-	30.000	87.0	21	31	3.12.56	30.000	87.0	21	31	3.12.56	Clear; lightning SW. quarter.	M	1	81
	1	1	-	-	30.210	86.5	22	30	3.12.16	30.210	86.5	22	30	3.12.16	Clear; lightning to the north.	M	1	81
Dec.	2	1	-	-	30.230	87.2	26	30	7.12.28	30.230	87.2	26	30	7.12.28	Clear.	M	1	81
	3	1	-	-	30.200	85.2	27	30	5.12.2	30.200	85.2	27	30	5.12.2	Ditto.	M	1	81
	24	1	-	-	30.088	80.0	15	31	0.12.4	30.088	80.0	15	31	0.12.4	Ditto.	M	1	81
Jan.	25	1	-	-	30.212	80.8	7.5	31	5.12.6	30.212	80.8	7.5	31	5.12.6	Ditto.	M	1	81
	26	1	-	-	30.140	78.5	11.0	32	0.12.8	30.140	78.5	11.0	32	0.12.8	Ditto.	M	1	81
	26	1	-	-	30.118	82.0	4	30	5.12.2	30.118	82.0	4	30	5.12.2	Clear; distant lightning in the SW.	M	1	81
Nov.	1	2	-	-	30.118	82.0	4	30	5.12.2	30.118	82.0	4	30	5.12.2	Clear; distant lightning in the SW.	M	1	81
	3	2	-	-	30.125	82.5	4	30.75	12.3	30.125	82.5	4	30.75	12.3	Clear.	M	1	81
	4	2	-	-	30.110	81.3	6	31	5.12.6	30.110	81.3	6	31	5.12.6	Ditto.	M	1	81
Dec.	7	2	-	-	30.172	79.0	15	30.75	12.3	30.172	79.0	15	30.75	12.3	Ditto.	M	1	81
	8	1	M	5	30.188	76.0	12	30	12.0	30.188	76.0	12	30	12.0	Ditto.	M	1	81
	2	2	E	8	30.186	80.4	16	30.25	12.1	30.186	80.4	16	30.25	12.1	Ditto.	M	1	81
Dec.	5	2	-	-	30.100	77.2	4	31	0.12.4	30.100	77.2	4	31	0.12.4	Ditto.	M	1	81
	9	1	-	-	30.205	77.5	1	31	0.12.4	30.205	77.5	1	31	0.12.4	Ditto.	M	1	81
	10	1	M	5	30.200	75.2	1.5	31	5.12.6	30.200	75.2	1.5	31	5.12.6	Ditto.	M	1	81
Jan.	1	1	E	8	30.188	77.2	3	30.75	12.3	30.188	77.2	3	30.75	12.3	Ditto.	M	1	81
	14	2	-	-	30.200	77.5	8.5	31	12.4	30.200	77.5	8.5	31	12.4	Hazy.	M	1	81
	16	2	M	5	30.155	76.2	6	30	5.12.2	30.155	76.2	6	30	5.12.2	Clear.	M	1	81
Dec.	1	1	E	8	30.160	77.5	9	30.75	12.3	30.160	77.5	9	30.75	12.3	Ditto.	M	1	81

Table VII. continued.

Month.	Day.	No. of Observations.	Morning or Evening.	Time.	Height of			Number of		Weather.
					Barom.	Therm.	Hygrom.	Feet.	Seconds.	
1851.				h.	Inches.	°	Dry.			
Jan.	18	1	M	5	30.200	76.5	8	30, 5	12, 2	Clear, and dew.
	19	2	E	8	30.156	79.2	3	31.75	12, 7	Cloudy.
	24	2	-	-	30.080	78.5	11, 5	31, 0	12, 4	Clear.
	27	1	M	5	30.115	76.5	9	30, 5	12, 2	Flying clouds.
	28	1	E	8	30.050	80.5	9, 5	30, 0	12, 0	Clear.
Feb.	30	2	-	-	30.035	77.8	12	31.25	12, 5	Ditto.
	1	1	M	5	29.998	74.5	8, 5	32, 0	12, 8	Hazy dew.
	6	2	E	8	30.125	76.0	12	30, 5	12, 2	Clear.
	7	1	M	5	30.100	72.0	12, 5	31, 5	12, 6	Ditto.
	7	2	E	8	30.148	75.5	13, 5	31.25	12, 5	Ditto.
	8	1	M	5	30.135	73.0	12, 0	30, 5	12, 25	Ditto.
	8	2	E	8	30.145	74.5	27	30.75	12, 3	Ditto.
	9	-	-	-	30.145	73.5	23	31, 0	12, 4	Ditto.
	10	-	-	-	30.200	76.0	20, 0	31, 0	12, 4	Ditto.
	15	-	-	-	30.184	78.0	14	31.25	12, 5	Ditto.
	16	-	-	-	30.188	78.0	15, 5	31	12, 4	Ditto.
	17	1	M	5	30.188	75.5	13, 0	31	12, 4	Ditto.
	17	2	E	8	30.182	76.0	14, 0	31.75	12, 7	Ditto.
	18	2	-	-	30.092	77.8	15	30.75	12, 3	Ditto.
March	2	1	M	5	30.165	73.5	14, 5	31, 0	12, 4	Ditto.
	2	2	E	8	30.125	81.5	15, 5	30, 5	12, 2	Ditto.
	3	-	-	-	30.110	79.2	17, 5	30, 5	12, 2	Ditto.
	9	-	-	-	30.124	81.0	14	31, 0	12, 4	Cloudy and lightning.
	27	1	-	-	30.085	83.0	18	30, 0	12, 2	Cloudy.
Mean					30.111	79.3	11.85	12.313		

TABLE VIII.

The wind having been south-easterly, mean of the observations of three days.

Month.	No. of Observations.	Mean height of			Number of		Weather.
		Barometer.	Therm.	Hygrom.	Beats.	Seconds.	
		Inches.		Dry.			
	6	29,925	83,9	11, 3	30, 0	12, 0	
	6	29,927	85,0	15, 1	30,65	12, 26	
	6	29,957	85,3	18, 3	30,15	12, 06	
	6	29,942	84,0	18, 3	30, 0	12, 0	
	6	29,955	84,4	17, 1	30,35	12, 14	
	6	29,955	82,6	14, 1	30, 5	12, 2	
	6	29,941	82,6	11, 3	30, 5	12, 2	
	6	30,008	83,2	14, 1	31, 0	12, 4	
	6	30,086	84,5	17, 7	30,65	12, 26	
	6	30,025	77,5	9, 2	30, 3	12, 12	
	6	30,155	78,4	14, 1	30, 9	12, 36	
	6	30,120	79,8	15, 2	31,05	12, 42	
	6	30,090	81,0	14, 3	31, 2	12, 04	
	6	30,065	80,3	17, 2	30, 9	12, 30	
	6	30,127	80,6	19, 2	31, 0	12, 4	
	6	30,043	81,5	11, 3	30,75	12, 3	
	6	30,055	82,3	12, 7	30, 7	12, 28	
	6	29,990	82,5	11, 3	31, 1	12, 44	
	4	30,084	83,5	15, 1	30,37	12, 14	
Mean -	-	30,023	82,3	14,60		12,231	

TABLE IX.

The wind having been north-easterly, mean of the observations of
three days.

Month.	No. of Observations.	Mean height of			Number of		Weather.
		Barometer.	Therm.	Hygrom.	Bess.	Seconds.	
1820.		Inches.		Dry.			
Oct.	6	30,132	81,3	12, 0	30,75	12, 3	Clear.
Nov.	6	30,181	80,7	11, 8	30, 5	12, 2	Ditto.
	6	30,178	79,4	7, 3	30, 7	12, 28	Cloudy.
	6	30,140	81,0	8, 7	30,15	12, 06	Ditto.
	6	30,105	78,7	7, 8	30, 6	12, 24	Clear.
	6	30,110	79,1	11, 3	30,75	12, 30	Ditto.
	6	30,170	78,5	14, 5	31, 1	12, 44	Ditto.
Dec.	6	30,119	78,1	1, 2	30,75	12, 3	Ditto.
	6	30,117	76,4	8, 0	31, 2	12, 48	Ditto.
	6	30,112	79,3	5, 0	30, 6	12, 24	Ditto.
	6	30,076	78,0	0, 5	31,05	12, 4	Ditto.
	6	30,083	78,9	2, 0	31, 0	12, 4	Cloudy.
				Damp			
Jan.	6	30,105	76,1	4, 8	31,35	12, 34	Clear.
				Dry.			
	6	30,183	76,8	2, 5	31, 1	12, 44	Ditto.
	6	30,148	77,9	8, 8	31, 0	12, 4	Cloudy.
	6	30,119	78,5	10, 0	30,85	12, 34	Clear.
Feb.	6	30,103	77,8	11, 2	31,15	12, 46	Ditto.
	6	30,180	78,2	14, 2	30,75	12, 3	Ditto.
Mean	-	30,131	78,6	7,33		12,340	

TABLE X.

The wind having been SW by W, and NW, mean of the observations of three days.

Month.	No. of Observations.	Mean height of			Number of		Weather.
		Barometer.	Therm.	Hygrom.	Bests.	Seconds.	
1820.		Inches.	°	Dry.			
August.	6	29.972	81, 0	9, 7	31, 5	12, 60	Cloudy and lightning.
	6	29.974	82, 0	8, 0	30, 85	12, 34	Mostly hazy.
	6	29.915	83, 2	13, 3	31, 15	12, 46	Ditto, ditto.
	6	29.868	85, 4	18, 0	31, 0	12, 4	Cloudy.
Sep. and Nov.	6	30.074	81, 8	16, 2	31, 0	12, 4	Mostly cloudy.
Dec. and Mar.	6	30.076	77, 7	3, 3	31, 4	12, 56	Hazy.
Mean		29.979	81, 85	11, 41		12, 46	

TABLE XI.

Mean motion of sound for each month, according to the experiments with the Mount gun.

Month.	Mean height of			Velocity in a second.
	Barometer.	Therm.	Hygrom.	
	Inches.	°	Dry.	Feet.
January.	30, 124	79, 05	6, 2	1101
February	30, 136	78, 84	14, 70	1117
March.	30, 072	82, 30	15, 32	1134
April.	30, 031	85, 79	17, 23	1145
May.	29, 892	88, 11	19, 92	1151
June.	29, 907	87, 10	24, 77	1157
July.	29, 914	86, 65	27, 85	1164
August.	29, 933	85, 02	21, 54	1163
September.	29, 903	84, 49	18, 97	1152
October.	30, 058	84, 33	18, 23	1158
November.	30, 125	81, 35	8, 18	1101
December.	30, 087	79, 37	1, 43	1099

J. GOLDINGHAM.

XII. *On the double Organs of Generation of the Lamprey, the Conger Eel, the common Eel, the Barnacle, and Earth Worm, which impregnate themselves; though the last from copulating, appear mutually to impregnate one another.* By Sir EVERARD HOME, Bart. V. P. R. S.

Read February 27, 1823.

IN May, 1806, I was so fortunate as to ascertain that the Tereidines are hermaphrodites, and that the same individual both formed and impregnated the ova.

In June, 1815, I found the lamprey also to be an animal of the same tribe; and on the present occasion, I wish to explain that the conger eel, the common eel, and the barnacle, are similar in their mode of generation, every one of these animals impregnating itself.

With respect to eels, I am disposed to agree in the opinion of the President of the Society, believing the conger and common eel to belong to the same species; and that the only difference between them is the one living in fresh, the other in salt water, which will explain the difference in their size and colour.

What renders this probable is, that Sir H. DAVY succeeded in getting a fresh water eel to live in salt water; and he understands that, after the eel has been accustomed to salt water for a year, its colours gradually change, acquiring a tint of green. The experiment was carried on in Cornwall, and the eel was sent alive, that we might have the opportunity

of judging for ourselves ; but it never arrived in London. He began with young small eels, which all died ; when however he took one of a tolerable size, it seemed to suffer little inconvenience.

The organs of generation in the conger and common eel are exactly similar ; and I have been so fortunate, on the first of February, 1823, to receive a conger from Plymouth, with ova distinctly visible in the microscope, and the structure of the testicles equally apparent. Out of three congeners sent to me, this state of the ova was only met with in one, so that they do not breed regularly in the same month. As this has not, I believe, been noticed before, I got Mr. BAUER to represent the parts in the annexed drawing, and thought it might be satisfactory to the Society to see a magnified drawing of these double organs in the lamprey, where they are brought closer upon one another by the absence of an air bladder, on the sides of which the ovaria of the common eel and conger are spread.

In the eel tribe the kidneys are immediately behind the peritonæum, and so closely connected with the testicle, when the eels are not caught in the breeding season, that the whole mass has been taken for kidney ; and had I not been favoured with the assistance of Mr. BAUER and Mr. CLIFT, I might have failed in procuring such accurate and distinct representations of these parts.

Mr. CLIFT, upon a former occasion, made a drawing of the testicles and ovarium of the lamprey, in which the parts were only sufficiently enlarged to identify the facts they were intended to demonstrate. I have now, to establish them more completely, taken advantage of Mr. BAUER's superior skill in

the use of the microscope to give, upon the same plate, the ovarium of the lamprey, and of the conger; wishing in my demonstration of such curious facts, that had escaped the accurate observation of JOHN HUNTER, they should, as far as may be, speak for themselves.

That species of barnacle, called *Lepas Anatifera*, has been examined, and drawings have been made of it by both these great anatomists, HUNTER and CUVIER; but their not having met with it in the breeding season, prevented them from seeing the manner in which the ova are disposed of, and led to considerable error with respect to the organs of generation.

The ovaria are situated round the œsophagus, and may, when not met with in the breeding season, be mistaken for the salivary glands; and the penis may be looked upon as the oviduct for depositing the ova after impregnation.

The curious circumstance in this species of *lepas* is, that the ova are impregnated before they leave the ovaria, by the point of the penis being bent down and carried for nearly one-fourth of an inch into them. After impregnation, the ova pass through a small opening in the outer covering into the stem by which the body of the barnacle is suspended; in that situation the ova are both defended and supplied with salt water; and, when the embryo is completely formed, it makes its way out, laterally from the stem, leaving behind the shell or covering of the egg attached to the inside of the tube, marking the place from which it escaped, the young *lepas* acquiring a stem of its own. In some cases the eggs all remain at the root of the stem, and come out externally, just opposite the opening in the outer covering.

All these circumstances are most distinctly illustrated by the drawings.

On the Organs of Generation of the Earth Worm.

It is now six years since Mr. BAUER very kindly offered me his assistance in this enquiry. Our joint labours have been frequently interrupted by subjects of more interest; we have, however, at last completed this investigation, and so much is represented in the drawings, that little is left for verbal description.

The mode of copulation resembles that of the leech more than of the snail; but when the animals are separated there is this curious difference: in the leech, an animal much smaller than the earth worm, there remains protruded a penis an inch long; a little lower down on the belly is the orifice leading to the uterus or ovarium; so that the first impression I received was, that the length of the penis enabled the leech to copulate with itself, till my friend, Dr. JOHNSON, laid before the Society an account of its copulation with another individual, which he had seen.

When two worms in copulation are forced asunder, there is upon neither of them any appearance of penis or vagina. There is a pair of longitudinal slits or suckers a little way from the head on each side of the belly of both worms; lower down a pair of hooks corresponding to each pair of suckers.

Their mode of copulation is as follows:

Two worms come out of two neighbouring holes a few inches apart, so that there is sufficient space for them to copulate, and for one-third of the length of each worm to remain

in the hole, which enables them to keep their hold of the ground; and whenever they are disturbed, they pull themselves asunder and retreat into their holes. In the act of copulation, as in the leech, the heads lie in opposite directions, so that the hooks of one worm attach themselves to the suckers of the other, which at that time swell out exceedingly, and form a cavity which is filled with mucus. The act of copulation is continued for a considerable time; Mr. BAUER has watched them for several hours before they separated.

The testicles and ovaria (in the breeding season) are shown in the annexed drawings to be very conspicuous in each individual worm; and although no canal from the one to the other has been detected, there can be no doubt that, the semen of the testicles arrives at the ovaria by the coats giving way. The ova, after impregnation, are conveyed into cells, of which there are two rows on each side of the animal, and there deposited.

It is in this situation the ova are hatched; and the young are for some time nourished by a substance supplied from a corrugated canal shown in the drawing, which is met with in the intestine, but having no communication with its cavity; this corrugated canal is firmly attached posteriorly to the parts behind the intestine, and sends off tubes to each of the cells in which the young are hatched: there is also an external orifice leading into each of them. In these cells the young go into the crysalis state, and when the young worm is ready to leave the crysalis covering, which is of an oval form, pointed at each end, one or more of these pointed ends are thrust out at the external orifice, so as to appear

externally, like so many feet for the progressive motion of the worm. The young worm does not remain immured till the crysalis covering is expelled, but eats its way out, leaving the middle broadest part of this covering sticking in the external orifice. The total absence of penis and vagina makes it difficult to explain what purpose is answered by the copulation; from the agitation produced by it through the whole of the bodies of the two worms, it seems necessary to distribute the ova to the numerous decipimenta in which they are met with.

This is somewhat different from the leech, whose ova are deposited in lateral cells, and are squeezed out at lateral orifices, covered with a mass of mucus, which at first encloses the whole leech. The animal disengages its head by means of the teeth, and then, by the wriggling of the body, escapes, leaving the mass of eggs and mucus curled up with a hole through it in the form of a ball, which the leech deposits upon the water, and there the young go through the crysalis state, and eat their way out and provide for themselves.

EXPLANATION OF THE PLATES.

PLATE XV. The LAMPREY.

Fig. 1. Anterior view of a portion of the ovarium and testicles of the lamprey, before the breeding season; magnified two diameters.

Fig. 2. A small portion of the same ovarium; magnified five diameters.

Fig. 3. Posterior view of a portion of the ovarium and testicles of the lamprey, in the breeding season; magnified two diameters.

Fig. 4. A small portion of the same ovarium; magnified five diameters.

Fig. 5. Anterior view of a portion of the ovarium, testicles, and the air bladder of the conger; natural size.

Fig. 6. A small portion of the same ovarium; magnified five diameters.

Fig. 7. A very small portion of the same; magnified fifty diameters.

PLATE XVI. The EARTH WORM.

Fig. 1. Exhibits a posterior or back view of a dead worm, in which state it is contracted; magnified two diameters.

Fig. 2. An internal view of the same worm laid open from behind; magnified two diameters.

Fig. 3. The upper portion of the same parts; magnified four diameters. In the middle line lies the great artery and the six lateral cells carrying red blood, and communicating between the great arterial and trunk, and the venal one on the opposite side or belly: the artery passes up to the head on the outside of the glandular mass surrounding the cesophagus, and through the space between the three portions of which the brain is composed, to go down the opposite or belly side of the animal. Immediately on the outside of the three lowest arterial cells are the ovaria and testicles. As the animal is divided through its whole length by decipimenta into compartments, one ovarium and one testicle lies on each side of the same compartment with the fourth arterial cell, and one testicle and ovarium in the same compartment with the fifth. In the sixth, there is an ovarium but no testicle. In the compartment below the arterial cells is one ovarium on each side very much developed, and directly between them is a hard cartilaginous circle, through which the cesophagus passes.

The other compartments contain membranous bags for the reception of ova. The two lowest ovaria are hanging loose. Before the breeding season they are empty. Towards the lower part, on each side, is the cut edge of the lateral slit, by means of which the animals adhere in the act of copulation.

In this space are included six compartments: in each of these is a large conspicuous gland of an oval form.

The course of the oesophagus, crop, gizzard, and intestine, can be traced behind the great artery.

PLATE XVII. THE EARTH WORM.

Fig. 1. An anterior or belly view of the perfect worm after death; magnified two diameters.

Fig. 2. The internal parts of the same worm: magnified two diameters.

Fig. 3. The same parts for a certain extent; magnified four diameters.

At the upper part is seen the brain, on each side of which go down two nervous elongations from two spherical ganglions situated on the opposite side to form the spinal marrow, which in this animal runs along the belly.

The spinal marrow is traced through its course, showing the artery belonging to its coats.

Many parts already described are seen in this view.

The lower developed ovaria appear in this view suspended upon the decipimentum. Immediately below them the termination of the oesophagus is seen, under which is the crop, then the gizzard, leading to the intestine.

PLATE XVIII. THE EARTH WORM.

Fig. 1. The same section as fig. 2, Plate XVII. magnified two diameters, showing the more internal parts for which purpose the spinal marrow is turned on one side: the intestine is laid open, exposing an hexangular tube, which has no communication with the intestine itself, but is posteriorly attached to that canal, and has two lateral openings into each compartment, showing the hexangular tube to be a reservoir of nutriment for the young.

Fig. 2. A posterior view of the outside of a portion of the intestine; magnified eight diameters.

Upon this portion of intestine are seven partial contractions formed by the transverse decipimenta, between each of which are two orifices leading to the lateral membranous bags from the hexagonal tube.

Between the two rows of openings is a longitudinal passage, forming a communication between the ovaria and the cells in the different compartments.

Fig. 3. A transverse section of a portion of fig. 2, seen anteriorly.

Fig. 4. A portion of intestine magnified as in fig. 2, laid open anteriorly to show the hexangular tube.

Fig. 5. The external appearance of the mouth and head; magnified six diameters.

Fig. 6. Shows the external appearance of the parts connected together in the time of copulation; magnified six times.

In the second ring from the top are two hemispherical protuberances with transverse slits.

In the eleventh ring are two protuberances, from which, during copulation, two spoon-like suckers are projected, but at other times withdrawn.

At the eighteenth ring begin the longitudinal lateral slits, and they are continued to the twenty-second. These are shown in an expanded state, in which they are only met with at the moment of the coitus.

In this view the openings from the compartments are distinctly seen. On the middle line of the belly are two rows, and other two rows on each side; these last are only distinctly seen in this drawing where the crysals are projecting through them.

PLATE XIX. THE EARTH WORM.

Fig. 1. A testicle and ovarium at the breeding season in situ; magnified twelve times.

Fig. 2. Ova taken from the ovarium; magnified fifty times.

Fig. 3. One of the membranous bags filled with eggs and worms removed from the compartment which contained it; magnified fifteen times.

a a a. Eggs ready to hatch; magnified fifty times.

b b b. Eggs hatching; magnified fifty times.

c c c. Two embryos hatched.

Fig. 4. A membranous bag taken from a compartment lower down in the worm; magnified fifteen times.

a a. Clusters of eggs and embryos agglutinated together; magnified thirty times.

Fig. 5. *a a.* The embryo in motion just before going into the crysalis state; magnified thirty times.

b. The change into the crysalis begun; magnified thirty times.

cc. The same, magnified fifty times.

Fig. 6. The tail portion of a worm, opened from behind; magnified four times.

To show that the ova and membranous bags are not met with at the lowest part of the worm, the compartments containing clusters of agglutinated ova, embryos, and crysals.

Fig. 7. One of the clusters of the last figure; magnified thirty times.

Fig. 8. The same cluster kept in water for fifteen minutes, and its contents exposed.

Fig. 9. Two perfect crysals from the same cluster; magnified fifty times.

PLATE XX. BARNACLES.

Fig. 1. A portion of the pedicle, with the shell from which the left valve is removed.

Fig. 2. A Longitudinal section of Fig. 1, to show the eggs within the fibrous substance of the pedicle; and the animal removed, to show the mantle in its natural position lining the shell; natural size.

Fig. 3. The entire animal taken out of the shell, and the mantle or lining of the shell turned back; magnified two diameters.

Fig. 4. The animal with the external membrane turned back, to show the eggs which accumulate there before they pass into the pedicle; magnified two diameters. In these two figures the tentacula of the right side are removed, to prevent confusion.

Fig. 5. The animal with all its integuments removed, and also the tentacula of the left side removed to show the natural position of the penis; magnified two diameters.

Fig. 1.



Fig. 3.

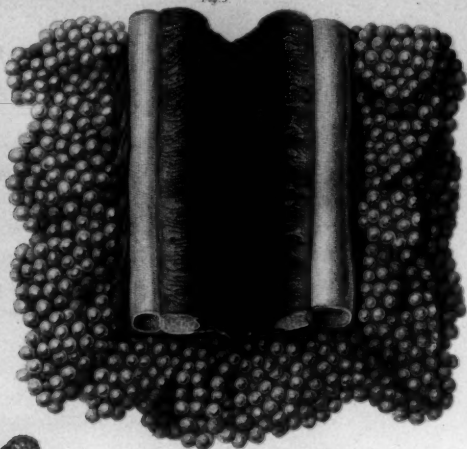


Fig. 2.

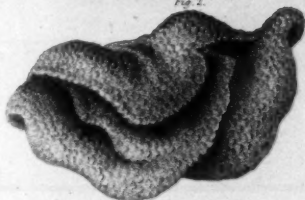


Fig. 4.



Fig. 5.

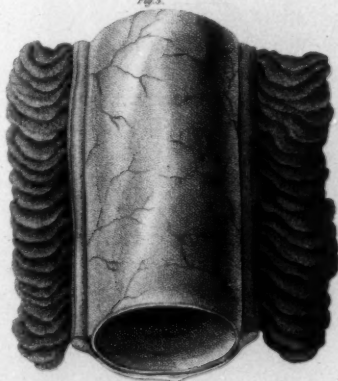


Fig. 6.

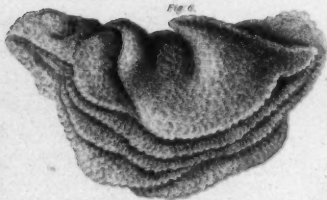
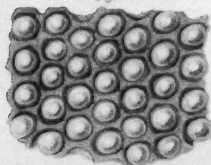


Fig. 7.



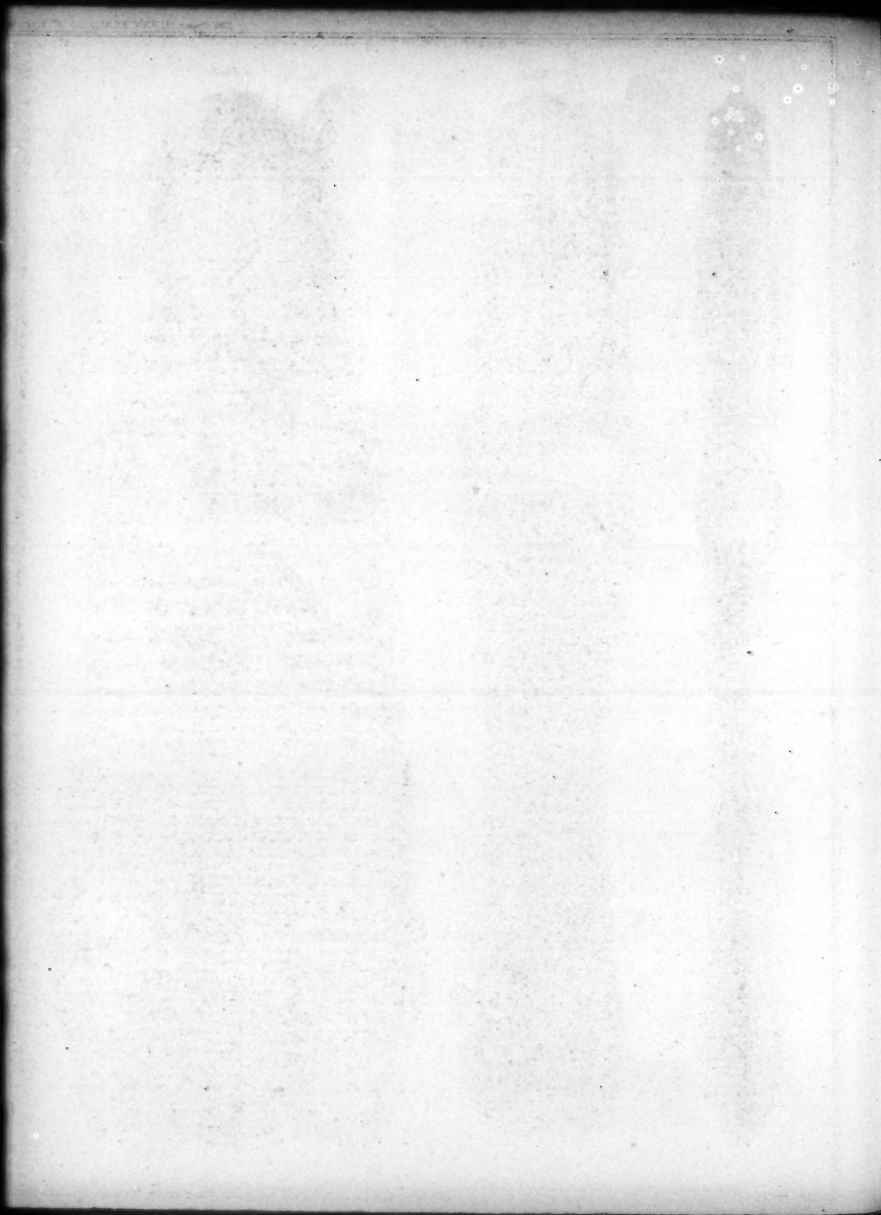


Fig. 1.

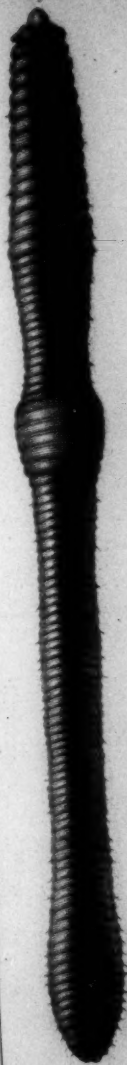


Fig. 2.

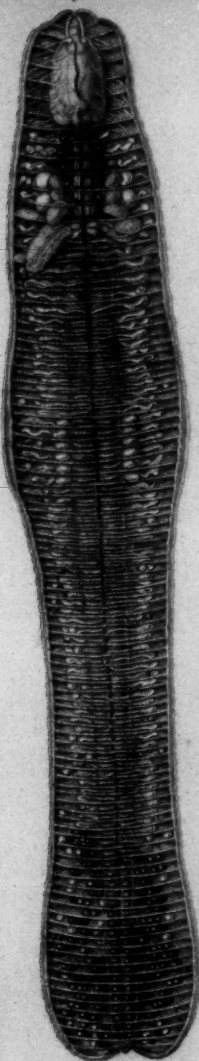


Fig. 3.

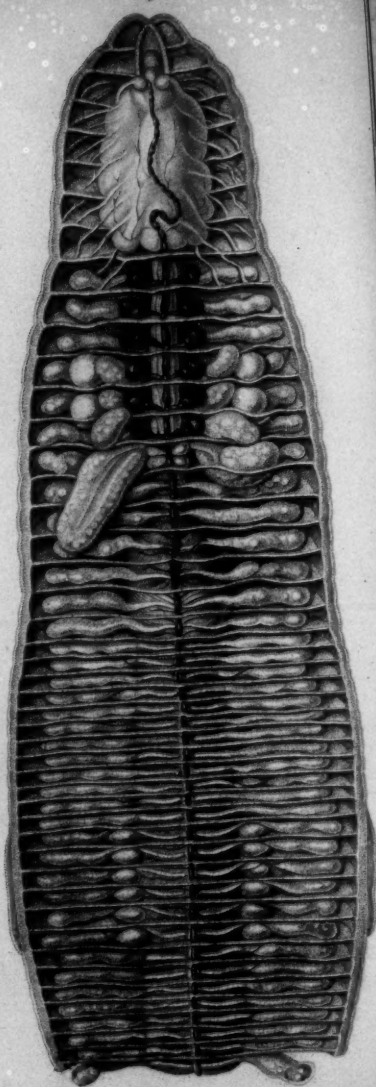




Fig. 1.

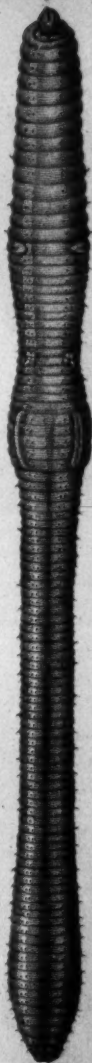


Fig. 2.

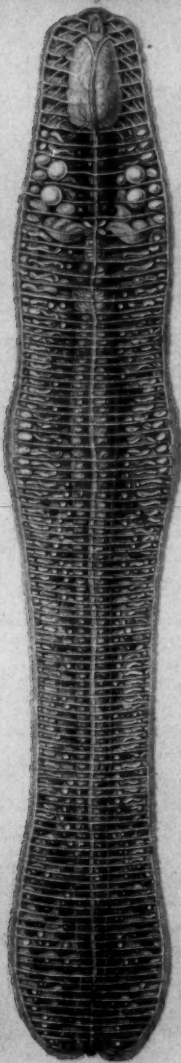
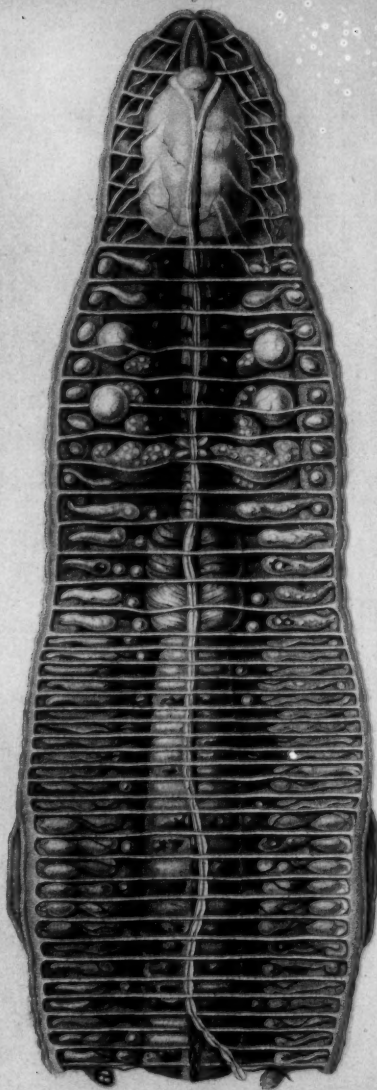


Fig. 3.



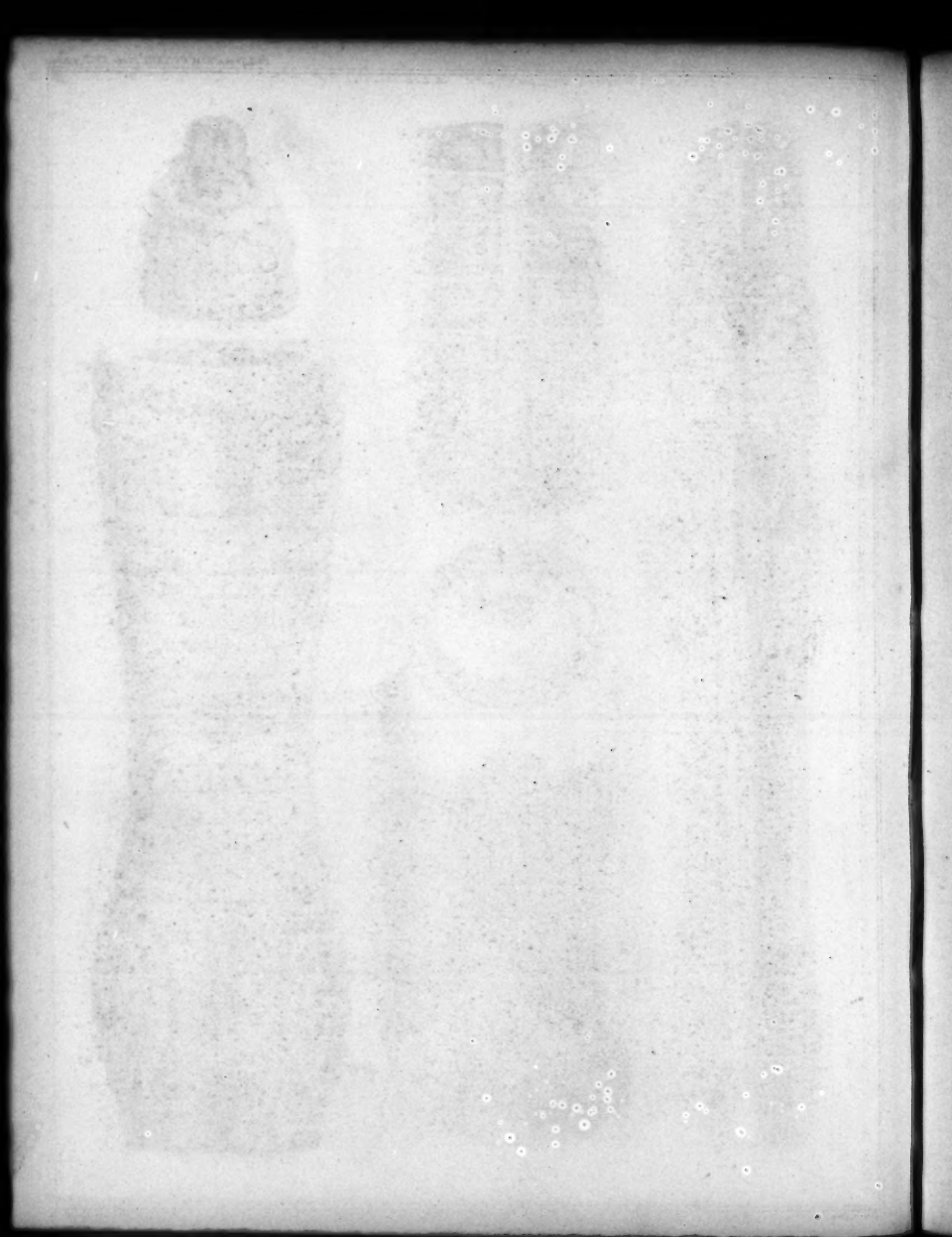
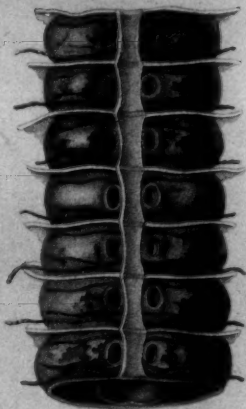


Fig. 1.



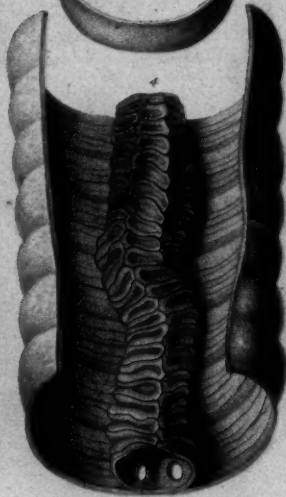
2



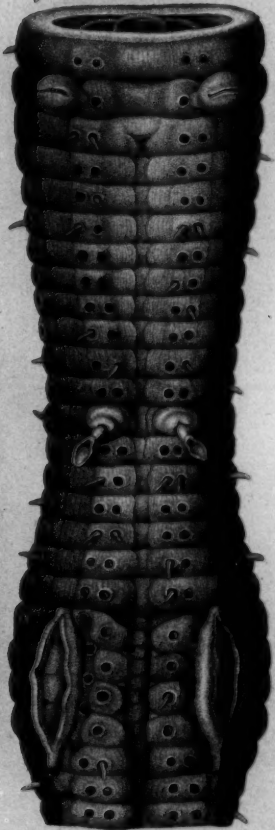
3

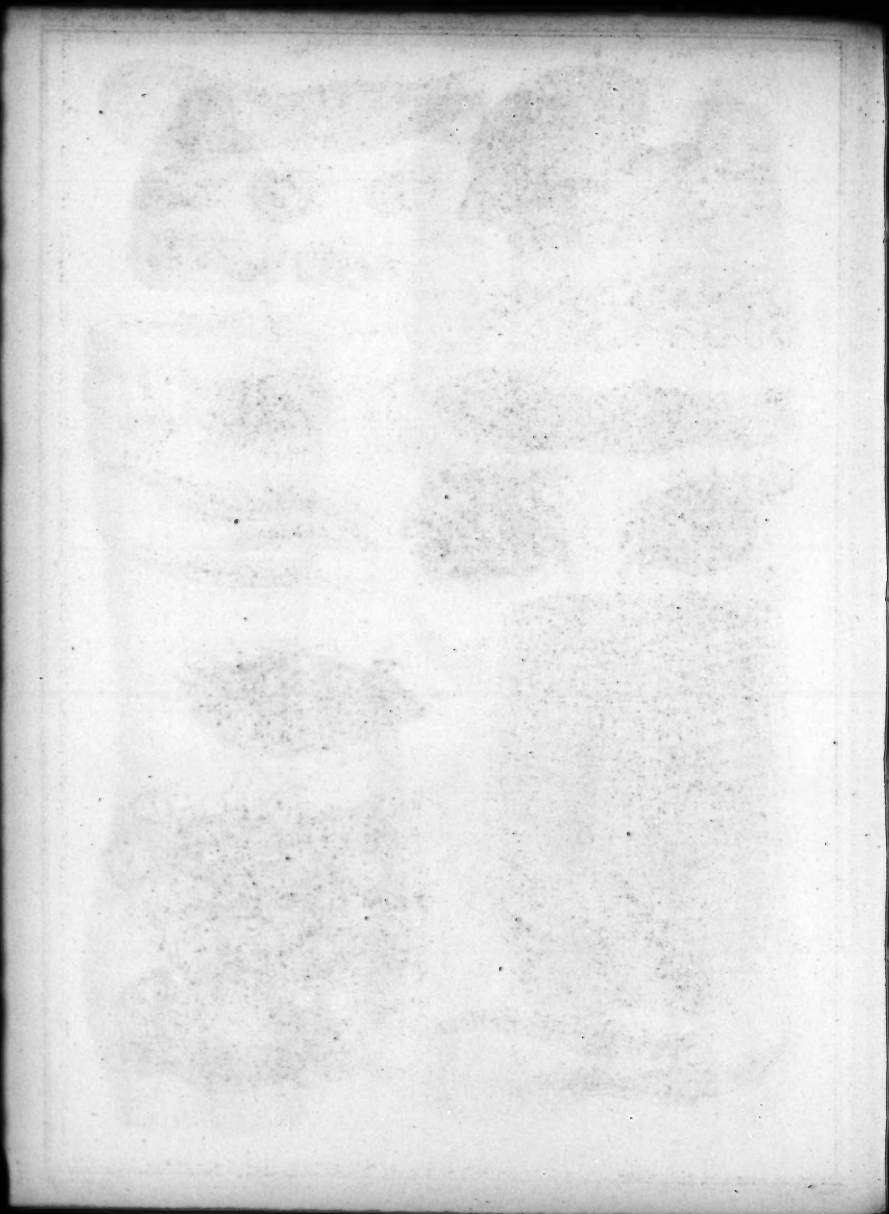


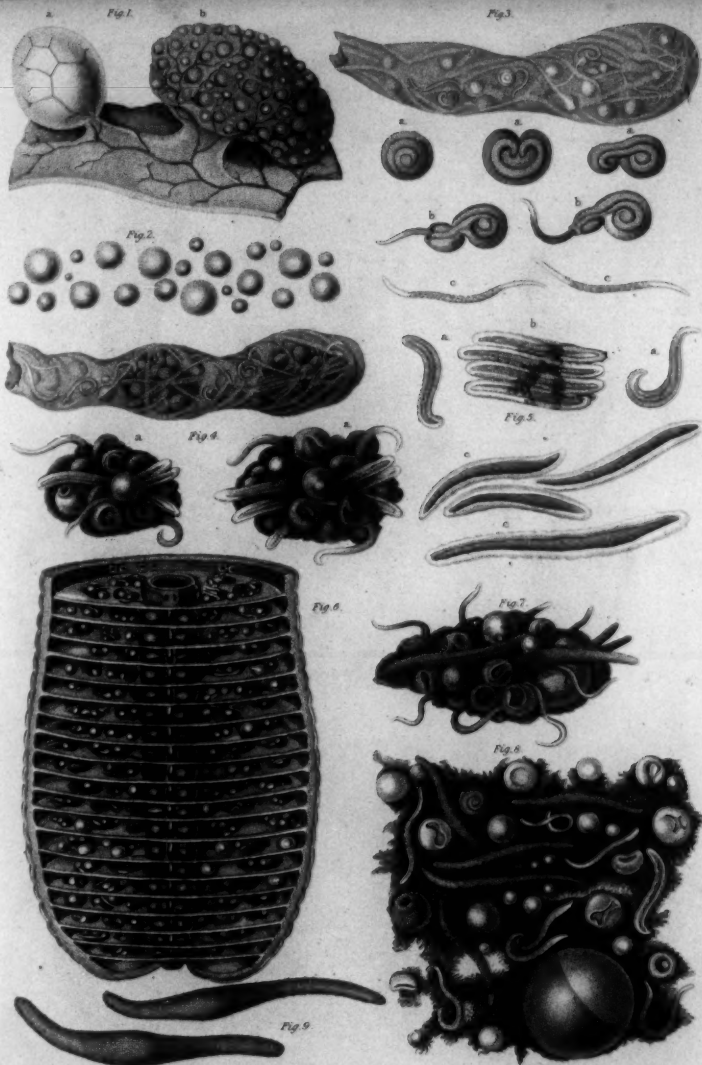
4



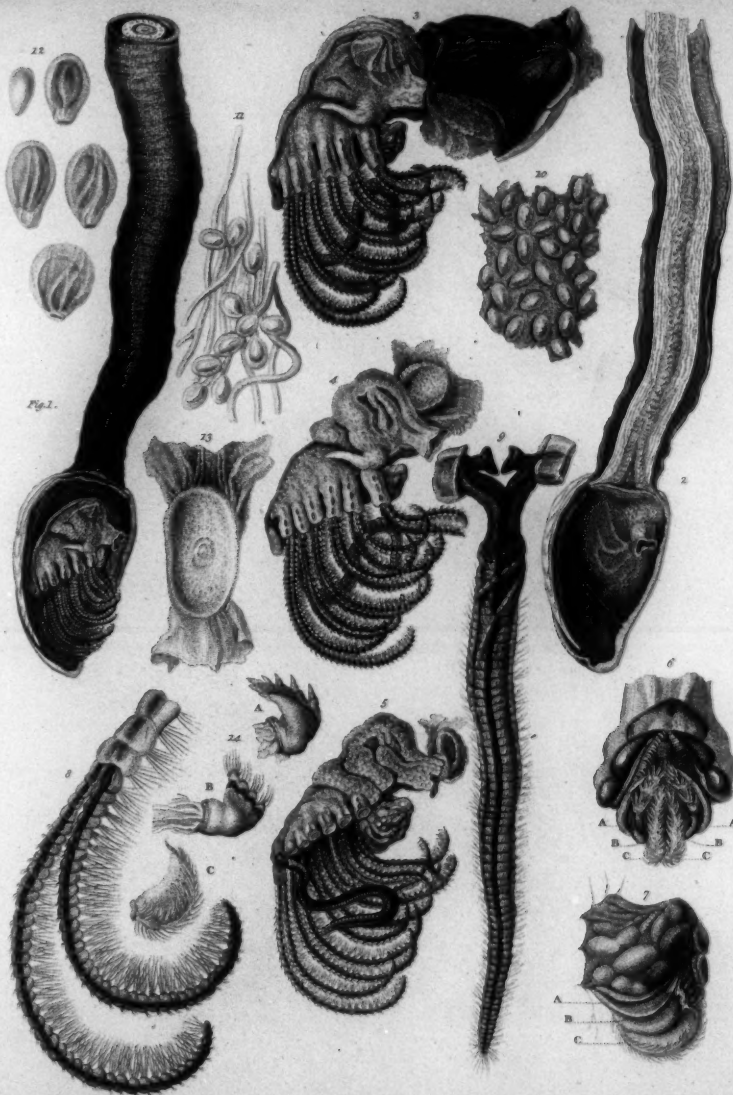
5











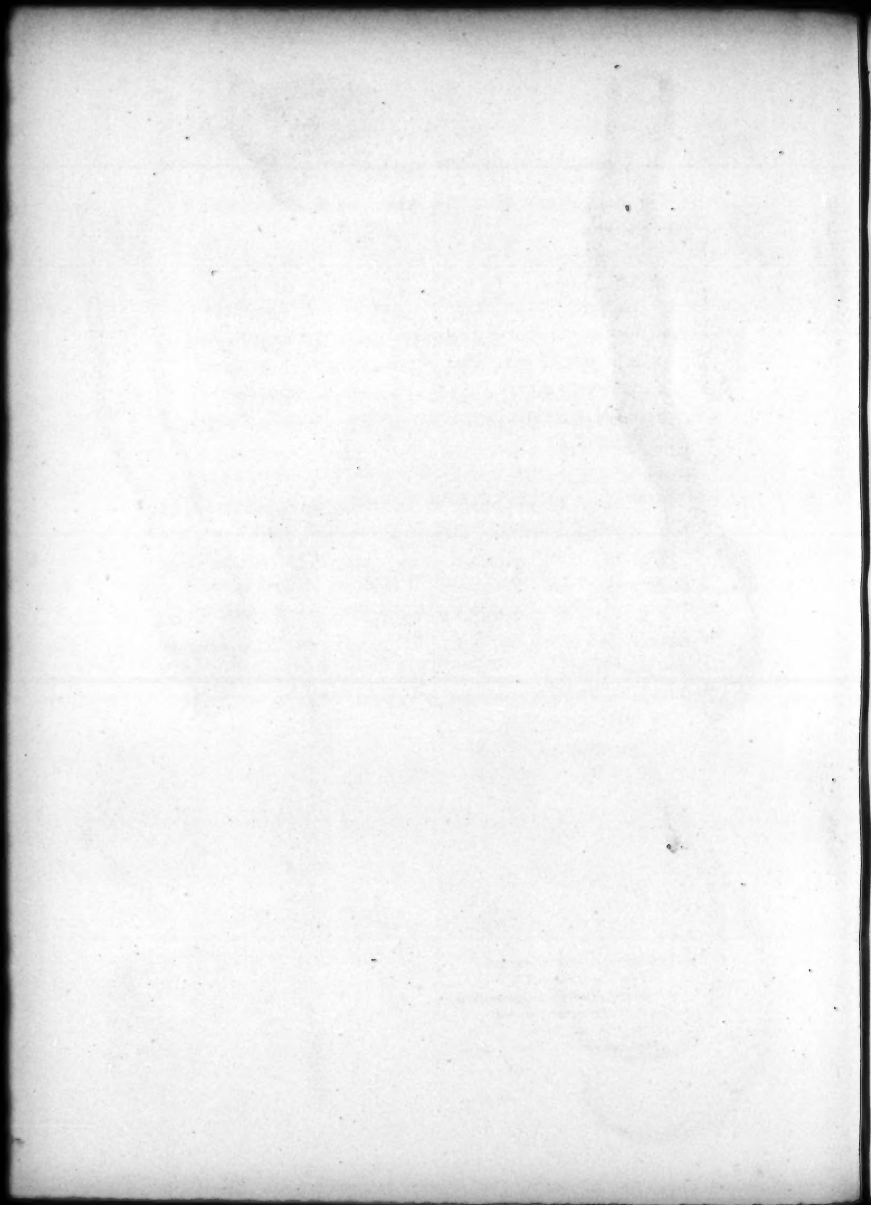


Fig. 6. A front view of the animal's head ; magnified four diameters.

A. External jaw.

B. Middle jaw

C. Internal jaw.

Fig. 7. Side view of the same ; magnified four diameters.

Fig. 8. One of the tentacula ; magnified four diameters.

Fig. 9. The penis ; magnified four diameters.

Fig. 10. A small portion of the eggs which are accumulating under the external integuments of the animal ; magnified fifty diameters.

Fig. 11. A small portion of the fibrous substance and eggs from within the pedicle ; magnified fifty diameters.

Fig. 12. Some separate eggs ; magnified one hundred diameters.

Fig. 13. The membrane lining the shell at the base of the pedicle, and of which the mantle is a continuation ; magnified two diameters.

Fig. 14. One of the outer jaws seen in fig. 6.

B. The middle jaw.

C. Internal jaw.

Fig. 6. A front view of the animal's head; magnified four diameters.

A. External jaw.

B. Middle jaw.

C. Internal jaw.

Fig. 7. Side view of the same; magnified four diameters.

Fig. 8. One of the tentacula; magnified four diameters.

Fig. 9. The penis; magnified four diameters.

Fig. 10. A small portion of the egg, which are sometimes found under the external integuments of the animal; magnified fifty diameters.

Fig. 11. A small portion of the fibrous substance and eggs from within the pedicle; magnified fifty diameters.

Fig. 12. Some separate eggs; magnified one hundred diameters.

Fig. 13. The membrane lining the shell at the base of the pedicle, and of which the mantle is a continuation; magnified two diameters.

Fig. 14. One of the outer jaws seen in fig. 6.

B. The middle jaw.

C. Internal jaw.

METEOROLOGICAL JOURNAL,

KEPT AT THE APARTMENTS

OF THE

ROYAL SOCIETY,

BY ORDER OF THE

PRESIDENT AND COUNCIL.

METEOROLOGICAL JOURNAL

for January, 1892.

1892	Time.		Therm.	Therm.	Barom.	Six's	Winds.		Weather.
	H.	M.	without.	within.	Inches.	Therm.	Points.	Str.	
Jan.	1	8 0	38	48	29.84	36	S	1	Cloudy and hazy.
		2 0	44	53	29.64	45	W	1	Fine.
	2	8 0	45	48	29.61	45	W	1	Fine.
		2 0	41	52	29.64	45	SSW	1	Cloudy and hazy.
	3	8 0	35	49	29.81	35	W	1	Hazy.
		2 0	40	51	29.70	41	S	1	Cloudy.
	4	8 0	37	48	29.10	36	E	1	Rain.
		2 0	39	51	29.45	41	WSW	1	Cloudy and Rain at inter-vals.
	5	8 0	35	47	29.77	36	N	1	Fine.
		2 0	39	51	29.91	41	ESE	1	Cloudy.
	6	8 0	35	47	29.99	35	N	1	Cloudy.
		2 0	37	46	30.02	40	E	1	Fine.
	7	8 0	34	45	29.92	33	NNW	1	Hazy thick weather.
		2 0	36	48	29.98	37	ESE	1	Cloudy.
	8	8 0	34	46	30.08	35	SSW	1	Cloudy.
		2 0	40	48	30.09	40	N	1	Cloudy.
	9	8 0	40	47	30.13	40	N	1	Hazy and cloudy.
		2 0	44	50	30.16	45	N	1	Fine.
	10	8 0	35	41	30.13	34	W	1	Fine, rather hazy.
		2 0	42	51	30.13	45	W	1	Fine.
	11	8 0	42	49	30.20	40	W	1	Cloudy and hazy.
		2 0	47	53	30.24	48	NW	1	Cloudy.
	12	8 0	43	50	30.31	41	W	1	Cloudy.
		2 0	48	54	30.31	48	W	1	Cloudy.
	13	8 0	45	50	30.30	44	W	1	Fine.
		2 0	49	54	30.29	49	W	1	Cloudy.
	14	8 0	43	50	30.26	42	W	1	Fine.
		2 0	47	54	30.26	49	W	1	Fine.
	15	8 0	40	49	30.12	40	N	1	Fine.
		2 0	43	53	30.20	47	N	1	Fine.
	16	8 0	34	40	30.18	34	WNW	1	Hazy.
		2 0	36	49	30.13	42	WNW	1	Fine.

Rain this Month 0.215 Inches.

METEOROLOGICAL JOURNAL

for January, 1822.

1822	Time.		Therm. without.	Therm. within.	Barom.	Sir's Therm.	Winds.		Weather.	
	H.	M.	°	°	Inches.		Points.	Str.		
Jan. 17	8	0	32	45	30.10	31	W	1	Cloudy; snow in the night.	
	2	0	38	49	30.12		W	1	Rain.	
18	8	0	35	48	30.29	35	W	1	Foggy.	
	2	0	43	53	30.34	45	W	1	Cloudy.	
19	8	0	41	48	30.35	35	W	1	Cloudy and foggy.	
	2	0	46	51	30.37	40	W	1	Cloudy.	
20	8	0	45	50	30.22	44	W	1	Cloudy.	
	2	0	49	49	30.29	50	W	1	Cloudy.	
21	8	0	40	47	30.28	39	W	1	Cloudy and hazy.	
	2	0	47	54	30.30	50	NW	1	Fine.	
22	8	0	43	50	30.43	43	W	1	Cloudy and hazy.	
	2	0	48	54	30.45	48	W	1	Cloudy.	
23	8	0	42	51	30.32	42	SSW	1	Fine.	
	2	0	48	54	30.25	48	W	1	Cloudy.	
24	8	0	43	51	29.85	42	S	1	Rain.	
	2	0	49	55	29.86	49	W by S	1	Cloudy.	
25	8	0	44	53	29.96	44	WNW	1	Cloudy.	
	2	0	48	55	30.00	49	N	1	Cloudy.	
26	8	0	43	52	30.10	42	W	1	Cloudy.	
	2	0	48	54	30.09	49	W	1	Fine.	
27	8	0	36	51	30.28	36	W	1	Fine.	
	2	0	43	51	30.31	49	S	1	Cloudy damp weather.	
28	8	0	46	50	30.21	48	W	1	Hazy.	
	2	0	50	58	30.17	50	W	1	Fine.	
29	8	0	38	51	30.18	38	W	1	Fine.	
	2	0	48	53	30.19	51	W	1	Cloudy.	
30	8	0	36	51	30.32	36	W	1	Hazy.	
	2	0	44	53	30.34	49	W	1	Fine.	
31	8	0	34	48	30.33	31	W	1	Fine; rather hazy.	
	2	0	43	53	30.30	44	W by S	1	Fine.	

METEOROLOGICAL JOURNAL

for February, 1892.

1892	Time.		Therm. without.	Therm. within.	Barom.	Six's Therm.	Winds.		Weather.
	H.	M.	°	°	Inches.		Points.	Dir.	
Feb.	1	8 0	41	51	30.23	39	SW	1	Fine.
		2 0	45	57	30.13	46	SW	1	Fine.
	2	8 0	45	53	29.84	39	SW	1	Cloudy.
		2 0	50	55	29.71	51	W	2	Cloudy.
	3	8 0	45	53	29.43	45	W	1	Fine.
		2 0	47	53	29.46	53	W	1	Fine.
	4	8 0	37	49	29.74	36	W	1	Fine: hoar frost.
		2 0	46	55	29.68	48	S	1, 2	Cloudy.
	5	8 0	47	52	29.30	41	SW	3	Rain.
		2 0	50	55	29.30	54	W	1	Rain.
	6	8 0	35	49	30.11	34	W	1	Fine.
		2 0	42	59	30.16	50	S	1	Fine.
	7	8 0	44	51	29.87	41	S	2	Fine.
		2 0	50	55	29.84	51	S	2	Cloudy.
	8	8 0	45	53	29.76	44	SW	2	Cloudy.
		2 0	49	57	29.91	51	SW	1	Cloudy.
	9	8 0	45	52	29.99	44	S	2	Cloudy.
		2 0	51	57	29.85	53	W	1	Cloudy.
	10	8 0	47	53	29.85	47	SSE	1	Cloudy.
		2 0	52	55	29.83	53	SE	1	Fine.
	11	8 0	42	52	29.96	42	SW	1	Fine.
		2 0	49	58	30.05	52	SSW	1	Fine.
	12	8 0	41	55	30.23	41	W	1	Thick fog.
		2 0	46	57	30.23	50	ESE	1	Fog.
	13	8 0	39	53	30.13	36	E	1	Foggy.
		2 0	49	58	30.09	49	S	1	Fine.
	14	8 0	43	53	30.11	42	SSE	1	Cloudy.
		2 0	50	56	30.10	50	S	1	Fine.
	15	8 0	43	56	30.09	42	S	1	Fine.
		2 0	52	60	30.09	53	SSW	1	Fine.

Rain this Month 0.560 Inches.

METEOROLOGICAL JOURNAL

for February, 1892.

1892	Time.		Therm. without.	Therm. within.	Barom.	Six's Therm.	Winds.		Weather.
	H.	M.	°	°	Inches.		Points.	Dir.	
Feb. 16	8	0	40	54	30.36	40	W	1	Hazy.
	2	0	47	59	30.41	52	W	1	Fine.
17	8	0	47	55	30.41	45	W	1	Cloudy.
	2	0	53	57	30.40	50	W	1	Fine.
18	8	0	45	55	30.40	42	WSW	1	Cloudy.
	2	0	53	59	30.37	54	S	1	Fine and clear.
19	8	0	45	56	30.42	44	N	1	Damp and foggy.
	2	0	50	59	30.38	51	W	1	Cloudy.
20	8	0	42	55	30.10	39	W	1,2	Cloudy.
	2	0	48	56	29.92	50	W	2	Cloudy.
21	8	0	37	52	30.37	36	NNW	1	Fine.
	2	0	47	56	30.43	45	NW	1	Fine.
22	8	0	37	54	30.44	36	S	1	Fine.
	2	0	46	60	30.32	48	W	1	Fine.
23	8	0	42	55	30.25	40	W	1	Hazy.
	2	0	46	58	30.29	46	WNW	1	Fine.
24	8	0	43	54	30.22	41	W	1	Cloudy.
	2	0	52	54	30.15	54	NNW	1,2	Cloudy.
25	8	0	48	54	30.24	48	W	1,2	Cloudy.
	2	0	53	56	30.23	54	W	1	Cloudy.
26	8	0	44	53	30.12	44	W	1,2	Fine.
	2	0	53	58	30.06	54	W	1	Cloudy.
27	8	0	39	53	30.50	38	W	1	Fine; rather hazy.
	2	0	47	56	30.63	49	N	1	Fine.
28	8	0	37	54	30.69	35	W	1	Hazy thick weather.
	2	0	46	59	30.58	48	S	1	Fine.

Rain this Month 0.560 inches.

METEOROLOGICAL JOURNAL

March, 1892.

1892	Time.		Therm. without.	Therm. within.	Barom.	Six's Therm.	Winds.		Weather.	
	H.	M.	°	°	Inches.		Points.	Str.		
Mar.	1	7	0	36	54	30.28	35	SE	1	Thick Fog.
		2	0	46	60	30.20	47	W	1	Fine.
	2	7	0	45	55	30.29	43	SW	1	Cloudy and hazy.
		2	0	53	57	30.28	53	S	1,2	Cloudy.
	3	7	0	43	53	30.29	43	SW	1	Fine.
		2	0	53	56	30.24	54	S	1	Fine.
	4	7	0	43	53	30.09	42	SW	1	Fine.
		2	0	53	57	29.99	53	SW	1	Fine.
	5	7	0	47	55	29.95	47	W	1	Cloudy.
		2	0	53	60	29.99	54	W	1	Fine.
	6	7	0	50	58	29.56	46	S	2,3	Rain.
		2	0	55	58	29.57	55	W	1	Cloudy.
	7	7	0	43	56	29.57	42	W	1	Fine.
		2	0	47	59	29.44	52	W	1	Rain.
	8	7	0	39	54	29.68	38	W	1	Cloudy.
		2	0	48	59	29.43	49	W	1	Rain.
	9	7	0	44	55	29.69	43	W	1	Fine.
		2	0	53	60	29.69	54	W	1	Rain.
	10	7	0	50	57	29.59	50	SW	1	Cloudy.
		2	0	57	58	29.56	57	W	1,2	Fine.
	11	7	0	42	52	29.78	40	W	1	Fine.
		2	0	47	58	29.97	52	NW	1,2	Cloudy.
	12	7	0	40	53	30.36	35	W	1	Hazy.
		2	0	48	56	30.36	48	SW	1	Fine.
	13	7	0	41	53	30.21	40	SSE	1	Fine.
		2	0	51	57	30.05	51	E	1,2	Fine.
	14	7	0	47	54	29.91	45	SSW	1	Cloudy.
		2	0	56	57	29.97	57	SW	1	Rain.
	15	7	0	41	55	30.22	41	NW	1	Cloudy and hazy.
		2	0	58	59	30.26	58	W	1	Fine.
	16	7	0	45	55	30.29	42	S	1,2	Fine.
		2	0	56	59	30.13	56	SSE	1	Cloudy.

Rain this Month 1.273 inches.

METEOROLOGICAL JOURNAL

for March, 1822.

1822	Time.		Therm. without.	Therm. within.	Barom.	Six's Therm.	Winds.		Weather.
	H.	M.	°	°	Inches.		Points.	Str.	
Mar. 17	7	0	51	56	30.27	50	W	1	Cloudy.
	2	0	54	57	30.19	56	SW	1	Rain.
18	7	0	48	57	30.23	48	NW	1	Cloudy.
	2	0	56	57	30.30	56		1	Cloudy.
19	7	0	50	57	30.28	46	SW	1	Cloudy.
	2	0	60	61	30.26	61	W	2	Cloudy.
20	7	0	51	57	30.32	50	W	1	Cloudy.
	2	0	58	60	30.25	60	W	1	Fine.
21	7	0	45	55	30.27	45	SW	1	Cloudy.
	2	0	58	60	30.15	58	W	1	Fine.
22	7	0	45	56	30.30	44	W	1	Fine.
	2	0	56	61	30.35	58	WNW	1	Fine.
23	7	0	42	54	30.24	40	W	1	Fine.
	2	0	59	60	30.06	59	SW	1	Fine.
24	7	0	48	57	29.60	46	W	1	Cloudy.
	2	0	52	56	29.61	60	NW	1, 2	Cloudy.
25	7	0	42	51	29.74	38	W	1	Cloudy.
	2	0	47	56	29.70	52	W by N	1	Rain.
26	7	0	43	53	30.04	38	WSW	1	Cloudy.
	2	0	57	58	30.11	58	NW	1	Cloudy.
27	7	0	50	56	30.20	49	W	1	Cloudy.
	2	0	58	60	30.17	59	S	1	Fine.
28	7	0	50	58	29.94	49	SW	1	Fine.
	2	0	65	63	29.92	66	SW	1	Fine.
29	7	0	47	57	30.38	45	W	1	Fine.
	2	0	62	62	30.39	65	W	1	Fine.
30	7	0	49	56	29.68	47	SW	2	Cloudy.
	2	0	53	61	29.46	55	W	2	Cloudy.
31	7	0	40	51	30.33	38	NE	2	Fine.
	2	0	42	52	30.35	47	NE	2	Fine.

Rain this Month 1.273 Inches.

METEOROLOGICAL JOURNAL

for April, 1892.

1892	Time.		Therm. without.	Therm. within.	Barom.	Six's Therm.	Winds.		Weather.
	H.	M.	°	°	Inches.		Points.	Str.	
April	7	0	40	50	30.34	38	N	1	Cloudy.
	8	0	47	56	30.32	48	N	1	Cloudy.
	9	0	43	51	30.30	41	N	1	Cloudy.
	10	0	49	57	30.31	50	N	1, 2	Fine.
	11	0	43	52	30.40	42	N	1	Cloudy.
	12	0	53	56	30.35	52	NW	1	Cloudy.
	13	0	45	54	30.34	43	N	1	Cloudy.
	14	0	52	58	30.16	53	NW	1	Cloudy.
	15	0	45	55	30.05	44	NW	1	Cloudy.
	16	0	54	55	30.00	54	N	1	Cloudy.
	17	0	45	52	29.89	47	N	1	Fine.
	18	0	54	57	29.85	54	NNE	1	Fine.
	19	0	43	52	29.95	40	N	1	Cloudy.
	20	0	49	54	29.95	53	W	1	Cloudy, but pleasant.
	21	0	41	52	30.02	39	N	1	Fine.
	22	0	46	58	30.03	50	N	1	Cloudy.
	23	0	37	50	30.09	35	N	1	Cloudy.
	24	0	46	56	30.06	48	N	1	Cloudy.
	25	0	37	48	30.04	36	N	1	Cloudy.
	26	0	46	54	30.01	47	ESE	1	Fine.
	27	0	39	50	30.01	37	E	1	Fine.
	28	0	48	58	29.90	48	E by S	1	Fine.
	29	0	41	52	29.72	41	E	1	Rain.
	30	0	53	57	29.72	53	N	1	Cloudy.
	1	0	45	54	29.85	44	SE	2	Rain.
	2	0	58	60	29.92	58	S	1	Fine.
	3	0	46	53	30.03	46	SE	1	Cloudy and foggy.
	4	0	57	56	29.96	59	E	1	Cloudy, but pleasant.
	5	0	50	54	30.00	49	E	1	Fine.
	6	0	63	59	29.98	61	E	1	Cloudy.

Rain this Month 1.620 Inches.

METEOROLOGICAL JOURNAL

for April, 1892.

1892	Time.		Therm. without.	Therm. within.	Barom.	Six's Therm.	Winds.		Weather.
	H.	M.	°	°	Inches.		Points.	Str.	
Apr. 16	7	0	49	56	29.94	49	N	1	Rain.
	2	0	54	58	29.99	55	N	1	Cloudy.
	7	0	43	57	29.92	43	E	1	Cloudy and dark.
17	2	0	53	61	29.80	55	E	1	Fine.
	7	0	46	56	29.66	46	NE	1	Cloudy.
18	2	0	51	59	29.64	52	E	1	Cloudy.
	7	0	44	55	29.68	46	W	1	Cloudy.
19	2	0	54	60	29.71	55	S	1	Fine.
	7	0	44	55	29.69	45	W	1	Fine.
20	2	0	55	60	29.69	56	W by S	1	Cloudy.
	7	0	46	57	29.61	46	W	1	Cloudy.
21	2	0	57	57	29.49	58	SW	1	Cloudy.
	7	0	47	56	29.37	46	S	2	Cloudy.
22	2	0	58	62	29.37	58	S	1	Fine.
	7	0	48	57	29.30	47	S	2	Cloudy.
23	2	0	55	62	29.41	56	W	1	Fine.
	7	0	48	54	29.62	44	S	2	Fine.
24	2	0	58	60	29.61	59	S	2	Fine.
	7	0	47	57	29.56	47	S	2	Rain.
25	2	0	57	60	29.58	58	W	1	Cloudy.
	7	0	46	55	29.82	43	W	1	Fine.
26	2	0	56	60	29.95	58	W	1	Fine.
	7	0	48	57	29.99	47	SW	1	Rain.
27	2	0	59	61	30.01	59	SW	1	Cloudy.
	7	0	51	58	30.25	50	W	1	Cloudy.
28	2	0	61	59	30.25	61	SW	1	Cloudy.
	7	0	48	57	30.23	47	E	1	Cloudy and hazy.
29	2	0	63	62	30.22	64	E	1	Fine.
	7	0	50	59	30.24	48	E	1	Fine.
30	2	0	63	63	30.26	64	E	1	Fine clear sky.

Rain this Month 1.650 Inches.

METEOROLOGICAL JOURNAL

for May, 1892.

1892	Time.		Therm. without.	Therm. within.	Barom.	Six's Therm.	Winds.		Weather.
	H.	M.	°	°	Inches.		Points.	Str.	
May	1	7 0	50	59	30.31	48	W	1	Fine clear sky.
		2 0	62	61	30.27	64	E	1	Fine and clear.
	2	7 0	50	59	30.17	46	E	1	Fine.
		2 0	62	62	30.09	62	E	1	Fine.
	3	7 0	47	59	29.96	45	E	1	Fine, rather hazy.
		2 0	62	62	29.86	62	E	1	Fine.
	4	7 0	54	60	29.61	53	E	1	Fine.
		2 0	65	63	29.59	66	E	1	Fine.
	5	7 0	53	60	29.68	52	NE	1	Rain.
		2 0	66	63	29.70	66	E	1	Fine.
	6	7 0	57	61	29.73	56	E	1	Cloudy and hazy.
		2 0	67	64	29.72	68	N	1	Cloudy.
	7	7 0	59	62	29.76	59	E	1	Cloudy and hazy.
		2 0	65	62	29.78	68	NE	1	Rain.
	8	7 0	49	59	29.95	47	NE	1	Cloudy.
		2 0	54	61	29.94	56	E	1	Fine.
	9	7 0	49	55	29.74	47	E	1	Cloudy.
		2 0	54	60	29.61	55	E	1	Cloudy.
	10	7 0	53	57	29.38	51	E	1	Cloudy and hazy.
		2 0	55	54	29.30	55	E	1	Fine.
	11	7 0	47	58	29.56	45	E	1	Fine.
		2 0	61	59	29.65	62	E	1	Cloudy.
	12	7 0	51	55	29.79	51	N	1	Cloudy.
		2 0	51	54	29.77	52	N	1	Cloudy.
	13	7 0	51	55	29.82	50	N	1	Cloudy and rather hazy.
		2 0	57	58	29.82	58	N	1	Cloudy.
	14	7 0	50	57	29.87	47	N by E	1	Fine.
		2 0	60	60	29.87	60	N	1	Fine.
	15	7 0	60	58	29.91	59	E	1	Fine.
		2 0	68	61	29.81	68	NE	1	Fine.
	16	7 0	52	59	29.98	50	E	1	Fine.
		2 0	62	62	29.95	62	E	1	Fine; no cloud to be seen.

Rain this Month 1.022 inches.

METEOROLOGICAL JOURNAL

for May, 1892.

1892	Time.		Therm.	Therm.	Barom.	Six's	Winds.		Weather.
	H.	M.	without.	within.	Inches.	Therm.	Points.	Dir.	
May 17	7	0	61	60	29.95	61	N by E	1	Fine.
	2	0	70	65	29.92	72	N	1	Fine.
18	7	0	62	63	29.99	60	N	1	Fine; rather hazy.
	2	0	70	67	30.01	72	N	1	Fine.
19	7	0	60	63	30.07	56	NNE	1	Fine.
	2	0	72	65	30.04	72	N	1	Fine.
20	7	0	60	64	30.13	56	E	1	Hazy.
	2	0	74	69	30.11	75	E	1	Fine.
21	7	0	60	65	30.25	58	N	1	Fine.
	2	0	74	70	30.25	74	NE	1	Fine.
22	7	0	55	64	30.46	53	N	1	Fine.
	2	0	70	68	30.30	70	E	1	Fine.
23	7	0	55	63	30.27	50	NE	1	Cloudy.
	2	0	63	65	30.19	65	NE	1	Fine.
24	7	0	56	63	30.08	52	E	1	Cloudy.
	2	0	64	64	30.02	65	NE	1	Fine.
25	7	0	54	63	29.96	50	E	1	Fine. [from 1 till 2] P.M.
	2	0	61	65	29.88	65	W	1	Thunder and lightning
26	7	0	56	62	29.80	53	W	1	Cloudy.
	2	0	55	61	29.78	60	SW	1, 3	Rain.
27	7	0	53	60	30.11	51	S	1	Fine.
	2	0	64	64	30.06	65	W	1	Fine clear sky.
28	7	0	61	62	30.17	60	W	1	Cloudy.
	2	0	68	64	30.20	69	NNW	1	Fine.
29	7	0	58	62	30.24	56	W	1	Fine.
	2	0	71	65	30.21	71	W	1	Fine.
30	7	0	55	62	30.31	53	W	1	Hazy.
	2	0	64	65	30.24	64	SW	1	Fine.
31	7	0	59	63	30.28	56	W	1	Fine.
	2	0	72	66	30.25	72	W	1	Fine.

Rain this Month 1.022 inches.

METEOROLOGICAL JOURNAL

for June, 1822.

1822	Time.		Therm.	Therm.	Barom.	Sis's	Winds.		Weathers.
	H.	M.	without.	within.	Inches.	Therm.	Points.	Dir.	
June	1	7 0	63	63	30.20	59	W	1	Fine.
	2	7 0	73	69	30.15	74	W by N	1	Fine.
	3	7 0	62	65	30.20	57	E	1	Fine.
	4	7 0	73	69	30.19	73	E	1	Fine.
	5	7 0	62	66	30.21	56	E	1	Fine.
	6	7 0	73	70	30.22	75	E	1	Fine.
	7	7 0	62	66	30.20	57	E	1	Fine.
	8	7 0	77	71	30.16	77	E	1	Fine.
	9	7 0	66	68	30.15	62	S	1	Hazy.
	10	7 0	78	71	30.15	70	E	1	Fine.
	11	7 0	66	69	30.17	62	N	1	Fine.
	12	7 0	75	72	30.13	80	E	1	Fine.
	13	7 0	64	66	30.20	60	N	1	Cloudy.
	14	7 0	74	70	30.13	78	E	1	Fine clear sky.
	15	7 0	58	66	30.10	54	N	1	Cloudy.
	16	7 0	74	70	29.98	74	E	1	Fine.
	17	7 0	65	68	29.92	60	E.	1	Fine.
	18	7 0	77	72	29.93	79	E	1	Fine.
	19	7 0	69	69	29.95	64	N	1	Fine. [at 9 P. M.
	20	7 0	81	74	29.94	84	SW	1	Fine; thunder and rain
	21	7 0	70	71	30.10	65	N	1	Fine.
	22	7 0	78	73	30.11	78	N	1	Cloudy.
	23	7 0	61	68	30.16	57	N	1	Fine.
	24	7 0	69	70	30.18	70	E	1	Fine.
13	1	7 0	54	62	30.20	50	E	1	Fine.
	2	7 0	70	70	30.08	70	E	1	Fine.
14	1	7 0	62	65	29.98	50	E	1	Fine.
	2	7 0	74	69	29.83	76	W	1	Cloudy.
15	1	7 0	67	67	29.65	63	ENE	1	Cloudy. [11 A. M.
	2	7 0	66	68	29.71	71	W	1	Fine; a thunder storm at

Rain this Month 1.212 Inches.

METEOROLOGICAL JOURNAL

for June, 1892.

1892	Time.	Therm. without.	Therm. within.	Barom.	Sir's Therm.	Winds.		Weather.
	H. M.	°	°	Inches.		Points.	Str.	
June 16	7 0	61	63	29.82	57	E	1	Cloudy.
	2 0	67	66	29.91	68	E	1	Cloudy.
17	7 0	58	63	30.16	54	E	1	Cloudy.
	2 0	65	65	30.19	66	NE	1	Cloudy.
18	7 0	59	62	30.22	54	SE	1	Fine.
	2 0	67	64	30.16	67	SE	1	Fine.
19	7 0	63	63	29.99	59	N by E	1	Fine, rather hazy.
	2 0	73	66	29.93	73	N	1	Cloudy.
20	7 0	61	63	29.93	59	N by E	1	Cloudy.
	2 0	65	63	30.02	70	NE	1	Cloudy.
21	7 0	55	63	30.19	51	NE	1	Fine.
	2 0	66	65	30.15	66	E	1	Fine.
22	7 0	59	63	30.13	53	E	1	Fine.
	2 0	73	68	30.06	73	E	1	Fine.
23	7 0	64	64	30.01	60	E	1	Cloudy; rain in the night.
	2 0	72	68	29.97	73	SSE	1	Fine.
24	7 0	66	65	30.01	63	W	1	Fine.
	2 0	73	67	30.00	75	W	1	Fine.
25	7 0	66	66	30.11	63	W	1	Fine.
	2 0	75	70	30.08	75	W	1	Fine.
26	7 0	67	67	30.07	62	W	1	Fine.
	2 0	76	71	29.97	77	SW	1	Fine.
27	7 0	65	68	30.06	62	N	1	Fine.
	2 0	73	70	30.15	77	N	1	Fine.
28	7 0	65	65	30.10	60	W	1	Cloudy.
	2 0	71	68	30.04	73	WSW	1	Cloudy.
29	7 0	60	65	30.00	59	NNE	1	Cloudy.
	2 0	70	65	30.05		NE	1	Cloudy.
30	7 0	60	64	30.03	56	SSW	1	Fine.
	2 0	65	65	29.91		W	1	Rain.

Rain this Month 1.212 inches.

METEOROLOGICAL JOURNAL

for July, 1822.

1822	Time.		Therm. without.	Therm. within.	Barom.	Sir's Therm.	Winds.		Weather.
	H. M.	°	°	Inches.			Points.	Str.	
July	1	7 0	62	63	30.06	56	NE	1	Fine.
		2 0	69	66	30.07	69	W	1	Fine.
	2	7 0	60	62	30.01	56	W	1	Fine.
		2 0	69	65	29.89	72	W	1	Cloudy.
	3	7 0	59	63	29.93	56	W	1	Fine.
		2 0	71	68	29.95	71	W	1	Fine.
	4	7 0	66	63	29.99	60	W	1	Fine.
		2 0	75	67	29.95	76	W	1	Cloudy. [lightning at 1 A.M.
	5	7 0	65	65	29.79	63	E	1	Cloudy; a storm of thunder and
		2 0	69	66	29.71	73	W by N	1	Cloudy; a thunder storm at 11 A.M.
	6	7 0	60	63	29.84	58	N	1	Cloudy.
		2 0	67	65	29.94	67	NNE	1	Cloudy.
	7	7 0	60	62	30.09	55	NE	1	Fine.
		2 0	70	65	30.08	71	NW	1	Cloudy.
	8	7 0	62	62	30.16	58	W	1	Cloudy.
		2 0	69	65	30.18	70	NW	1	Fine.
	9	7 0	64	64	30.08	63	W	1	Cloudy.
		2 0	69	66	30.02	71	W	1	Rain.
	10	7 0	65	63	29.87	62	SW	1,2	Cloudy.
		2 0	71	67	29.84	71	W	1	Fine.
	11	7 0	65	64	29.86	61	W	1	Cloudy.
		2 0	69	65	29.73	72	S	1	Cloudy.
	12	7 0	62	63	29.41	60	W	1	Fine.
		2 0	67	64	29.44	68	NNW	1	Fine.
	13	7 0	58	62	29.81	54	N	1	Fine.
		2 0	68	64	29.93	69	W by N	1	Fine.
	14	7 0	59	62	30.02	55	NE	1	Fine.
		2 0	69	65	30.00	70	N by E	1	Fine.
	15	7 0	59	62	29.98	55	E	1	Cloudy and hazy.
		2 0	69	64	29.88	70	E	1	Cloudy.
	16	7 0	61	63	29.78	58	N	1	Fine.
		2 0	69	64	29.74	70	N	1	Cloudy.

Rain this Month 2.788 Inches.

METEOROLOGICAL JOURNAL

for July, 1893.

1893	Time.		Therm.	Therm.	Barom.	Six's	Winds.		Weather.
	H.	M.	°	°	Inches.	Therm.	Points.	Str.	
July 17	7	0	62	63	29.68	60	W	1	Rain.
18	2	0	66	64	29.72	70	S	1	Cloudy.
	7	0	65	63	29.74	60	E	1	Fine.
19	2	0	73	68	29.70	73	E	1	Cloudy. [ning at 3 A.M.
	7	0	64	65	29.50	64	S	1	Rain; thunder and light-
20	2	0	72	67	29.53	72	S	1	Fine.
	7	0	66	65	29.51	61	S	1	Cloudy.
21	2	0	70	67	29.57	72	SW	2	Fine.
	7	0	66	65	29.58	61	S	1	Fine.
22	2	0	69	66	29.53	71	S	1	Cloudy.
	7	0	65	65	29.55	63	S	1	Cloudy.
23	2	0	71	66	29.73	71	NNW	1,2	Cloudy.
	7	0	65	64	29.79	62	S	1	Cloudy.
24	2	0	70	65	29.75	71	S	1,2	Cloudy.
	7	0	67	65	29.59	62	SW	1	Cloudy.
25	2	0	70	68	29.62	72	S	1	Fine.
	7	0	65	65	29.66	61	SW	1,2	Rain.
26	2	0	71	66	29.68	71	SW	2	Cloudy.
	7	0	63	64	29.76	58	W	1	Fine.
27	2	0	70	66	29.74	71	S	1	Cloudy.
	7	0	62	64	29.80	58	SW	1	Fine clear sky.
28	2	0	71	66	29.79	72	SW	1	Fine.
	7	0	66	65	29.54	62	S	1	Fine.
29	2	0	69	66	29.50	70	SSW	1	Showery.
	7	0	64	63	29.52	64	NW	1	Cloudy.
30	2	0	69	65	29.49	70	S	1	Cloudy.
	7	0	62	63	29.54	59	NW	1	Fine.
31	2	0	66	64	29.57	66	SW	1	Cloudy.
	7	0	60	60	29.68	55	SW	1	Fine.
	2	0	62	62	29.68	67	W	2	Rain.

Rain this Month 2.788 inches.

METEOROLOGICAL JOURNAL

for August, 1892.

1892	Time.		Therm. without.	Therm. within.	Barom.	Sir's Therm.	Winds.		Weather.	
	H.	M.	°	°	Inches.		Point.	Dir.		
Aug.	1	7	57	59	29.80	51	W	by N	1	Fine.
	2	0	64	62	29.80	66	W		1	Fine.
	3	7	58	60	29.73	56	W		1	Hazy.
	4	0	60	61	29.81	65	W		1	Fine; a hail storm at 1
	5	7	56	59	30.01	50	W		1	Fine.
	6	0	65	61	30.02	65	N	by E	1	Cloudy.
	7	0	58	61	29.89	55	N	by E	1	Fine.
	8	0	67	62	29.81	67	NW		1	Cloudy.
	9	7	59	61	29.86	53	N		1	Fine.
	10	0	68	62	29.88	66	N		1	Fine.
	11	7	58	61	30.03	53	NW		1	Cloudy.
	12	0	65	62	30.02	68	N		1	Cloudy.
	13	7	61	61	30.06	59	W		1	Cloudy.
	14	0	69	64	30.08	70	W		1	Cloudy.
	15	7	59	61	30.03	57	E		1	Cloudy and hazy.
	16	0	71	63	29.91	72	E		1	Cloudy.
	17	7	60	62	29.76	57	W		1	Fine.
	18	0	68	64	29.75	68	W		1	Cloudy.
	19	7	63	63	29.80	62	W		1	Fine.
	20	0	70	64	29.81	70	W		1	Cloudy.
	21	7	65	63	29.82	63	W		1	Cloudy.
	22	0	70	64	29.82	70	W		1	Cloudy.
	23	7	64	64	29.84	62	W		1	Cloudy.
	24	0	70	65	29.84	70	W		1	Cloudy.
	25	7	65	64	29.79	62	SW		1	Cloudy.
	26	0	71	66	29.84	71	NNW	1,2	1	Fine.
	27	7	66	65	29.92	63	WSW	1	1	Fine.
	28	0	69	66	29.82	71	S	1,2	1	Cloudy.
	29	7	61	65	29.69	63	N		1	Cloudy.
	30	0	68	66	29.86	70	W	by N	1	Cloudy.
	31	7	60	63	30.07	54	W		1	Cloudy.
	32	0	68	67	30.07	70	NW		1	Fine.

Rain this Month 0.975 inches.

METEOROLOGICAL JOURNAL

for August, 1892.

1892	Time.		Therm. without.	Therm. within.	Barom.	Six's Therm.	Winds.		Weather.
	H.	M.	°	°	Inches.		Points.	Str.	
Aug. 17	7	0	61	64	30.23	59	W	1	Fine.
	2	0	73	71	30.20	76	W	1	Fine.
18	7	0	62	66	30.19	68	W	1	Cloudy.
	2	0	73	71	30.15	75	W	1	Fine.
19	7	0	63	67	30.13	67	NE	1	Cloudy.
	2	0	74	71	30.15	75	SE	1	Fine.
20	7	0	62	67	30.14	66	ESE	1	Fine.
	2	0	70	71	30.14	71	E	1	Fine.
21	7	0	64	67	30.02	62	N	1	Hazy.
	2	0	70	73	29.97	78	E	1	Fine.
22	7	0	70	70	29.89	68	W	1	Cloudy.
	2	0	78	73	29.87	79	W	1	Fine, rather cloudy.
23	7	0	65	70	29.97	63	NE	1	Cloudy.
	2	0	78	72	29.98	80	WNW	1	Cloudy.
24	7	0	59	66	29.82	59	SW	1	Cloudy.
	2	0	67	68	29.79	70	S	1	Cloudy. [cloudy.
25	7	0	60	66	29.74	55	W	1	Fine, though somewhat
	2	0	67	65	29.74	68	W	1,2	Cloudy.
26	7	0	59	64	29.68	56	W	1	Fine.
	2	0	66	65	29.65	67	W by N	1	Fine.
27	7	0	60	64	29.69	56	W	1	Fine.
	2	0	61	64	29.70	66	W by N	1	Showery.
28	7	0	60	64	29.72	57	W	1	Cloudy.
	2	0	66	64	29.63	66	ESE	2,1	Cloudy and showery.
29	7	0	60	63	29.47	58	W	1	Fine.
	2	0	65	64	29.53	67	W	2	Cloudy.
30	7	0	57	62	29.77	54	W	1	Fine.
	2	0	66	62	29.80	66	SW	1	Cloudy.
31	7	0	57	61	29.91	52	W	1	Fine.
	2	0	65	65	29.94	66	NW	1	Fine.

Rain this Month 0.975 Inches.

METEOROLOGICAL JOURNAL

for September, 1822.

1822	Time.		Therm.	Therm.	Barom.	Sir's	Winds.		Weather.
	H.	M.	without.	within.	Inches.	Therm.	Points.	Str.	
Sept. 1	7	0	55	63	30.11	53	W by S	1	Cloudy.
	2	0	65	64	30.11	65	W	1	Cloudy.
2	7	0	58	60	30.08	54	SW	1	Fine.
	2	0	65	62	30.03	68	W	2	Cloudy.
3	7	0	62	62	29.94	61	W	1	Fine.
	2	0	68	64	29.91	69	W	1	Fine.
4	7	0	58	61	30.04	56	W	1	Fine.
	2	0	68	72	30.04	69	W	1	Fine.
5	7	0	63	64	29.93	61	W	1	Fine.
	2	0	68	65	29.85	70	WSW	1	Cloudy.
6	7	0	65	64	29.83	63	SW	1	Cloudy.
	2	0	68	69	29.83	70	WSW	1	Fine.
7	7	0	66	62	30.04	54	W	1	Fine.
	2	0	65	66	30.07	68	W by N	1	Fine.
8	7	0	58	62	29.92	55	W	1	Cloudy.
	2	0	66	64	29.89	68	W	1	Rain.
9	7	0	56	60	29.98	54	NW	1	Cloudy.
	2	0	64	62	29.96	66	WSW	2	Cloudy.
10	7	0	52	61	30.12	51	W	1	Fine.
	2	0	59	62	30.08	64	W	1	Fine.
11	7	0	58	63	29.92	51	S	1, 2	Fine.
	2	0	64	64	29.94	67	NW	1	Cloudy.
12	7	0	54	60	29.95	53	NW	1	Fine, rather hazy.
	2	0	62	61	30.01	65	N by E	1	Cloudy.
13	7	0	56	59	29.97	54	N	1	Cloudy.
	2	0	60	63	30.08	61	N	1	Cloudy.
14	7	0	50	59	29.91	45	E	1	Fine.
	2	0	63	61	30.16	62	E	1, 2	Cloudy.
15	7	0	56	60	30.08	53	E	1	Cloudy and hazy.
	2	0	60	61	30.01	61	E	1	Cloudy.

Rain this Month 0.702 Inches.

[19]

METEOROLOGICAL JOURNAL

for September, 1892.

1892	Time.		Therm.	Therm.	Barom.	Sir's	Winds.		Weather.	
	H.	M.	without.	within.	Inches.	Therm.	Points.	Dir.		
Sept. 16	7	0	54	60	30.04	52	W	1	Fine.	
	1	0	60	64	30.03	66	W	1	Fine.	
17	7	0	57	61	30.06	55	W	1	Cloudy and hazy.	
	1	0	70	63	30.05	70	B	1	Fine.	
18	7	0	55	61	30.08	52	N by E	1	Cloudy and hazy.	
	1	0	63	69	30.09	70	S by E	1	Fine.	
19	7	0	57	62	30.14	53	E	1	Fine.	
	1	0	63	68	30.12	65	E	1.2	Fine.	
20	7	0	55	60	29.99	52	N	1	Fine.	
	1	0	60	71	29.93	64	E	1	Fine.	
21	7	0	58	60	29.83	53	E	1	Fine.	
	1	0	59	68	29.84	62	E	1	Fine.	
22	7	0	54	59	29.88	59	E	1	Cloudy.	
	1	0	61	60	29.86	62	E	1	Cloudy.	
23	7	0	55	56	29.82	55	E	1	Rain.	
	1	0	58	59	29.65	62	ENE	1	Rain.	
24	7	0	57	57	29.44	56	B	1	Rain.	
	1	0	60	60	29.31	60	E	1	Cloudy and showery.	
25	7	0	52	57	29.31	51	NE	1	Fine.	
	1	0	57	58	29.45	58	NE	1	Cloudy.	
26	7	0	49	68	29.67	47	N	1	Cloudy and hazy.	
	1	0	57	61	29.84	59	NE	1	Fine.	
27	7	0	49	55	30.07	48	NE	1.2	Fine.	
	1	0	56	57	30.16	57	SE	2	Cloudy.	
28	7	0	51	56	30.21	49	N	1	Rain.	
	1	0	56	57	30.17	57	N	1	Cloudy.	
29	7	0	51	56	30.03	49	NE	1	Fine.	
	1	0	58	57	29.96	59	E	1	Fine.	
30	7	0	49	56	29.86	46	W	1	Cloudy and hazy.	
	1	0	59	62	29.79	59	SE	1	Cloudy.	

Rain this Month 0.702 Inches.

METEOROLOGICAL JOURNAL

for October, 1899.

1899	Time.		Therm.	Therm.	Barom.	Sir's	Winds.		Weather.
	H.	M.	without.	within.	Inches.	Therm.	Points.	Dir.	
Oct. 1	8	0	48	57	29.71	46	N	1	Hazy.
	2	0	59	60	29.68	59	SE	1	Fine.
	3	0	57	59	29.74	55	E	1	Cloudy.
	3	0	63	60	29.75	64	E	1	Cloudy.
	3	0	60	59	29.70	57	E	1	Rain.
	3	0	65	62	29.68	65	E	1	Cloudy.
	4	0	59	61	29.78	58	S	1	Cloudy. [evening.
	4	0	64	65	29.71	66	W	1	Fine; much lightning this
	5	0	60	62	29.70	58	SW	1	Fine.
	5	0	63	62	29.68		SW	1	Fair.
	6	0	54	61	29.53	52	W	1	Fine.
	6	0	59	60	29.57	60	W	1	Cloudy.
	7	0	55	59	29.43		W	2	Fine.
	7	0	59	63	29.61				Cloudy.
	8	0	58	60	29.56	55	W	3	Rain.
	8	0	59	63	29.62	60	W	1,2	Fine.
	9	0	57	60	29.71	53	S	2	Cloudy.
	9	0	52	60	29.82	50	W	1	Fine.
	10	0	52	60	29.82	50	W	1	Fine.
	10	0	64	64	29.91	60	NW	1	Fine.
	11	0	48	59	30.14	46	W	1	Fine.
	11	0	58	63	30.15	59	SW	1	Fine.
	12	0	54	60	29.97	52	SE	1	Cloudy.
	12	0	60	62	29.81	61	SE	1	Cloudy.
	13	0	58	61	29.45	59	S	2	Cloudy.
	13	0	61	61	29.38	62	SE	1,2	Rain.
	14	0	46	59	29.83	46	N	2	Fine.
	14	0	52	61	29.98	52	N	1,2	Cloudy.
	15	0	43	57	29.93	41	W	1	Fine.
	15	0	50	59	29.74	51		1	Rain.
	16	0	50	58	29.37	48	E	1	Cloudy and hazy.
	2	0	53	60	29.32	54	W	1	Rain.

Rain this Month 3.055 Inches.

METEOROLOGICAL JOURNAL

for October, 1892.

1892	Time.	Therm. without.	Therm. within.	Barom.	Six's Therm.	Winds.		Weather.
	H. M.	°	°	Inches.		Points.	Str.	
Oct. 17	8 0	51	57	29.31	50	N by E	2	Rain.
	2 0	51	58	29.34	53	N	2	Cloudy and Rain
18	8 0	41	56	29.61	41	NW	1	Fine; rather hazy.
	2 0	50	59	29.66	50	W	1	Fine.
19	8 0	48	56	29.49	46	S	1.2	Cloudy.
	2 0	53	59	29.47	55	W	1.2	Fine.
20	8 0	54	58	29.55	52	S	1.2	Cloudy.
	2 0	59	58	29.41	59	SW	3	Rain.
21	8 0	53	57	29.54	51	S	1.2	Fine.
	2 0	59	59	29.61		S	1	Fine.
22	8 0	48	58	29.72	47	W	1	Fine.
	2 0	59	60	29.81	59	SW	1	Fine.
23	8 0	46	56	29.70	44	E	1	Fine, rather hazy.
	2 0	55	58	29.57	56	E	1	Cloudy.
24	8 0	57	57	29.38	55	SSE	1	Cloudy.
	2 0	61	59	29.36	62	E	1	Cloudy.
25	8 0	55	58	29.48	55	S	1	Fine.
	2 0	60	60	29.51	62	S by E	1	Fine.
26	8 0	53	58	29.53	52	E	1	Fine.
	2 0	58	59	29.43	60	SE	1	Cloudy.
27	8 0	52	58	29.53	51	NW	1	Cloudy.
	2 0	55	59	29.58	57	W	1	Fine.
28	8 0	44	47	29.77	43	E	1	Hazy and cloudy.
	2 0	54	58	29.84	55	SSW	1	Fine.
29	8 0	53	56	29.88	49	S	1	Rain.
	2 0	59	57	29.96	59	N	1	Cloudy.
30	8 0	55	56	29.97	53	E	1	
	2 0	60	58	29.93	61	SW	1	Cloudy.
31	8 2	54	56	29.69	52	E	1	Fine.
	2 2	60	60	29.71	61	S	1	Fine.

Rain this Month 3.053 Inches.

METEOROLOGICAL JOURNAL

for November, 1892.

1892	Time.		Therm. without.	Therm. within.	Barom.	Six's Therm.	Winds.		Weather.	
	H.	M.	°	°	Inches.		Points.	Str.		
Nov.	1	8	0	56	58	29.86	53	S	2	Cloudy.
	2	0	60	58	29.83	51	S	2	Cloudy.	(the night.
	3	8	0	60	59	29.69	58	SE	1	Fine; rain and wind in
	2	0	61	62	29.70	61	S	1	Cloudy.	
	3	8	0	54	56	29.97	53	SW	1	Fine.
	2	0	58	57	30.04	61	SW	1	Cloudy.	
	4	8	0	48	54	30.26	47	W	1	Hazy.
	2	0	52	57	30.26	58	W	1	Fine.	
	5	8	0	52	56	30.27	47	SW	1	Cloudy.
	2	0	56	58	30.20	57	SW	1	Cloudy.	
	6	8	0	52	57	30.18	51	W	1	Cloudy.
	2	0	56	60	30.13	57	W	1	Cloudy.	
	7	8	0	50	57	29.95	49	S	1	Fine.
	2	0	54	59	29.95		S	1	Fine.	
	8	8	0	49	58	29.93	49	W	1	Cloudy.
	2	0	57	61	29.93	58	N by E	1	Cloudy and dark.	
	9	8	0	43	58	29.94	43	N	1	Thick fog.
	2	0	49	57	30.01	56	N	1	Cloudy.	
	10	8	0	50	57	29.70	48	N	1	Rain.
	2	0	53	58	29.88	53	N by E	1	Cloudy.	
	11	8	0	46	57	30.24	46		1	Thick fog.
	2	0	57	60	30.24	58	S	1	Fine.	
	12	8	0	52	58	30.22	49	SSE	2	Cloudy.
	2	0	55	59	30.02	56	S	1.2	Cloudy.	
	13	8	0	48	48	29.92	47	NW	1	Foggy.
	2	0	50	60	29.75	51	W	1	Fine; streaky clouds.	
	14	8	0	46	55	29.40	45	W	1	Fine.
	2	0	51	59	29.51	52	W	1	Fine.	
	15	8	0	48	57	29.24	45	SW	2	Cloudy.
	2	0	47	59	29.29	49	W	1	Fine.	
	16	8	0	42	50	29.29	42	N	1	Rain.
	2	0	42	58	29.29	48	NNW	1	Rain.	

Rain this Month 1.607 Inches.

METEOROLOGICAL JOURNAL

for November, 1892.

1892	Time.		Therm.	Therm.	Barom.	St's	Winds.		Moon.		Weather.	Tide.
	H.	M.	without.	within.	Inches.	Therm.	Point.	Dir.	Phase.	Time.		
Nov. 17	8	0	41	55	29.61	39	WSW	1			Fine.	
	2	0	48	56	29.62	48	WSW	1			Cloudy.	
18	8	0	51	54	29.62	47	S	2,3			Rain.	
	2	0	52	58	29.68	55	SW	1			Fine.	
19	8	0	52	56	29.86	50	S	1,2			Cloudy.	
	2	0	54	58	29.78	55	SW	1			Cloudy.	
20	8	0	53	57	29.63	53	E	1			Rain and fog.	
	2	0	54	59	29.63	56	S	1			Rain.	
21	8	0	52	58	29.60	54	W	1,2			Cloudy.	
	2	0	53	61	29.72	55	W	1			Fine.	
22	8	0	47	57	29.88	45	S	1			Cloudy.	
	2	0	51	60	29.72	52	S	2,3			Rain.	
23	8	0	51	58	29.61	51	W	2			Rainy and squally.	
	2	0	51	59	29.64	53	SW	1			Fine.	
24	8	0	47	57	29.88	46	W	1			Fine.	
	2	0	53	57	29.79	53	S	1			Cloudy.	
25	8	0	51	56	29.55	54	S	2			Rain.	
	2	0	52	59	29.50	53	SSW	1,2			Fine.	
26	8	0	48	56	29.53	48	W	1			Fine.	
	2	0	52	60	29.55	53	S	2			Cloudy.	
27	8	0	51	57	29.57	50	WSW	1			Fine.	
	2	0	53	59	29.65	56	W	1			Fine.	
28	8	0	45	56	29.52	44	S by E	2			Rain.	
	2	0	48	60	29.31	50	S	1			Cloudy.	
29	8	0	41	56	29.47	41	W	1			Fine.	
	2	0	48	58	29.30	48	S	1,2			Cloudy.	
30	8	0	38	54	29.36	38	SW	1			Fine.	
	2	0	45	55	29.37	45	W	1			Rain.	

Rain this Month 3.607 Inches.

METEOROLOGICAL JOURNAL

for December, 1822.

1822	Time.		Therm. without.	Therm. within.	Barom.	Sir's Therm.	Winds.		Weather.
	H.	M.	°	°	Inches.		Points.	Str.	
Dec.	1	8 0	42	53	29.31	40	S	1	Fine.
	2	0	54	54	29.16	54	SSW	2	Rainy and squally.
	3	8 0	40	52	29.07	40	SW	1	Fine.
	4	0	48	55	29.04	50	SSW	1	Fine.
	5	8 0	41	52	29.23	41	NNW	1	Cloudy and foggy.
	6	0	42	55	29.41	43	NNW	1	Fine.
	7	8 0	39	51	29.59	38	SW	1	Fine.
	8	0	48	54	29.42	48	SW	1,2	Rain.
	9	0	37	51	29.75	36	W	1	Fine.
	10	0	42	54	29.67	45	S	1,2	Cloudy.
	11	8 0	43	52	29.50	47	W	1	Fine.
	12	0	45	56	29.64	47	W by N	1	Fine.
	13	8 0	39	52	29.94	38	W	1	Fine.
	14	0	43	55	29.98	43	NW	1	Fine.
	15	8 0	38	51	30.22	37	W	1	Fine.
	16	0	41	52	30.18	43	SW	1	Fine.
	17	8 0	46	51	30.13	42	S	2	Cloudy.
	18	0	47	54	30.09	48	SW	2	Rain.
	19	8 0	41	52	30.33	41	N	1	Fine, rather hazy.
	20	0	44	54	30.42	47	NE	1	Fine.
	21	8 0	37	51	30.54	35	N	1	Foggy.
	22	0	37	53	30.56	42	N	1	Foggy.
	23	8 0	37	51	30.57	37	NNE	1	Foggy.
	24	0	42	53	30.55	43	E	1	Fine.
	1	8 0	38	52	30.40	37	E	1	Fine.
	2	0	42	53	30.32	43	E	1	Hazy.
	3	8 0	37	51	30.26	37	E	1	Cloudy.
	4	0	40	53	30.24	41	SW	1	Cloudy.
	5	8 0	36	50	30.08	35	E	1	Cloudy.
	6	0	38	49	30.03	40	E	1	Cloudy.
	7	8 0	35	48	30.18	35	NNE	1	Cloudy and hazy.
	8	0	34	50	30.22	35	NE	1	Cloudy and hazy.

Rain this Month 1.641 Inches.

METEOROLOGICAL JOURNAL

for December, 1822.

1822	Time.		Therm. without.	Therm. within.	Barom.	Six's Therm.	Winds.		Weather.
	H.	M.	°	°	Inches.		Points.	Str.	
Dec. 17	8	0	34	47	30.33	34	NNW	1	Cloudy and hazy.
	2	0	36	50	30.31	37	W	1	Cloudy and hazy.
	8	0	44	47	30.23	37	N	1	Cloudy and hazy.
	2	0	40	49	30.22	47	N by E	1	Rain.
	8	0	39	47	30.27	37	NW	1	Fine.
	2	0	38	49	30.28	40	NE	1	Cloudy.
	8	0	31	48	30.35	31	N by E	1	Fine, but rather hazy.
	2	0	34	50	30.36	36	E	1	Fine.
	8	0	31	46	30.34	29	N	1	Fine.
	2	0	35	49	30.29	36	N	1	Fine.
	8	0	34	45	30.14	30	N	1	Fine.
	2	0	39	46	30.09	39	NE	1	Cloudy.
	8	0	38	44	30.07	35	N	1	Hazy.
	2	0	42	48	30.03	43	NE	1	Cloudy.
	8	0	38	46	30.05	37	E	1	Foggy.
	2	0	40	48	30.09	42	E	1	Cloudy.
	8	0	36	45	30.42	34	E	1	Cloudy and hazy.
	2	0	36	45	30.43	37	E	1	Cloudy and hazy.
	8	0	31	44	30.45	31	E	1	Hazy.
	2	0	35	48	30.38	36	SE	1	Fine.
	8	0	32	44	30.37	30	E	1	Cloudy and hazy.
	2	0	44	44	30.32	44	ESE	1	Cloudy.
	8	0	28	42	30.27	27	E	1	Hazy.
	2	0	32	46	30.20	34	E by S	1	Fine.
	8	0	30	41	30.15	27	E	1	Cloudy.
	2	0	31	42	30.08	35	E	1	Fine.
	8	0	25	39	29.83	23	E	1	Fine.
	2	0	31	43	29.80	29	SE	1.2	Fine.
	8	0	30	40	29.74	28	E	1	Cloudy and dark.
	2	0	32	45	29.71	32	E	1	Cloudy.

Rain this Month 1.241 Inches.

1822.	Thermometer without.			Thermometer within.			Barometer.*			Six's Thermometer.			Rain.†
	Greatest height.	Least height.	Mean height.	Greatest height.	Least height.	Mean height.	Greatest height.	Least height.	Mean height.	Greatest height.	Least height.	Mean height.	
	Deg.	Deg.	Deg.	Deg.	Deg.	Deg.	Inches.	Inches.	Inches.	Deg.	Deg.	Deg.	
January	50	32	41.5	58	41	50.3	30.17	29.10	30.107	51	31	43.2	0.215
February	53	35	45.6	60	49	55.0	30.69	29.30	30.102	54	34	45.5	0.560
March	65	36	49.5	63	51	56.7	30.36	29.43	30.030	66	35	49.5	1.273
April	63	37	49.6	63	48	56.3	30.40	29.30	29.921	64	35	49.5	1.620
May	74	47	59.4	70	54	61.6	30.46	29.30	29.959	75	45	58.8	1.022
June	81	54	67.0	74	62	67.0	30.29	29.65	30.064	84	50	64.6	1.212
July	75	58	66.1	68	60	64.4	30.18	29.41	29.775	76	53	64.9	2.788
August	78	56	64.8	73	59	64.7	30.23	29.47	29.992	80	50	64.3	0.975
September	70	49	58.6	72	55	61.6	30.21	29.31	29.941	70	45	58.6	0.702
October	65	41	55.1	65	47	59.0	30.15	29.31	29.663	66	41	54.3	3.053
November	61	38	50.6	62	54	57.6	30.27	29.24	29.748	61	38	49.7	3.607
December	54	25	38.1	56	39	49.0	30.57	29.04	30.059	54	23	58.0	1.041
Whole year			53.8			58.6			29.863			55.0	18.068

* The quicksilver in the basin of the barometer is 81 feet above the level of low water spring tides at Somerset-house.

† The Society's Rain Gage is 114 feet above the same level, and 75 feet 6 inches above the surrounding ground.

The mean variation of the Magnetic Needle will be given in Part II.